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**SITE SPECIFIC  
SAFETY PLAN**

**Rocky Mountain Arsenal  
Information Center  
FOR  
Commerce City, Colorado**

**INTERIM ACTION  
ROCKY MOUNTAIN ARSENAL  
BASIN F**

**May, 1987**



Submitted to: U.S. Army Corps of Engineers Omaha District



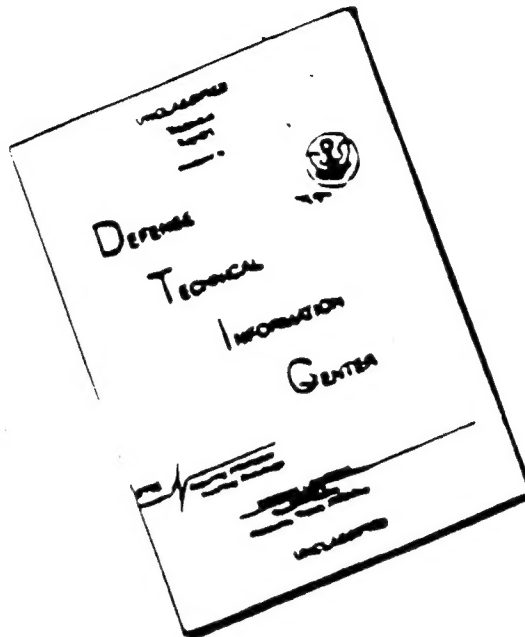
Submitted by: Woodward-Clyde Consultants  
in association with  
HDR Infrastructure, Inc.



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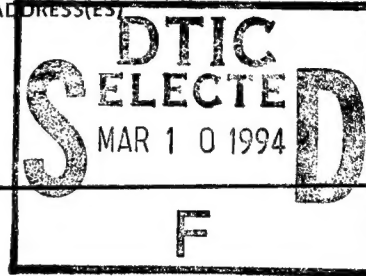
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**SITE SPECIFIC SAFETY PLAN**

**FOR**

**INTERIM ACTION**

**ROCKY MOUNTAIN ARSENAL  
BASIN F  
DENVER, COLORADO**

**MAY, 1987**

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## TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
1.0 GENERAL INFORMATION	1
1.1 Introduction	1
1.1.1 Adherence to the Safety Plan	1
1.1.2 Availability of the Safety Plan	2
1.1.3 Site Visitors	2
1.2 SSSP	3
1.3 Regulations and Guidelines	4
1.4 Scope of Services	4
2.0 STAFF ORGANIZATION, RESPONSIBILITIES, AUTHORITIES, AND QUALIFICATIONS	6
2.1 Authorized Personnel	7
2.2 Corporate Health and Safety Officer (CHSO)	8
2.3 Project Manager	9
2.4 Site Health and Safety Officer (SHSO)	11
2.5 Health and Safety Technicians	11
2.6 Air Monitoring Specialist	12
2.7 Contract Compliance Field Engineer	12
3.0 SITE BACKGROUND	12
3.1 Site Location	13
3.2 Site Description	13
3.2.1 RMA Access	13
3.2.2 Perimeter Identification	13
3.2.3 Topography	16
3.2.4 Surficial Geology	16
3.2.5 Unusual Features	17
3.2.6 Status of Site	17
3.2.7 Expected Weather Conditions	17
3.3 Site History	17
3.3.1 Basin Details	20
3.3.2 Basin F Operations	21
3.3.3 Previous Remedial Actions	27
3.4 Rocky Mountain Arsenal (RMA) History	28
4.0 WASTE CHARACTERIZATION	29
4.1 Types	29
4.2 Containment	29
4.3 Chemical and Toxicological Characteristics	32
5.0 SUSPECTED HAZARDS AND ASSESSMENTS	32
5.1 Toxic and Hazards Substances	35
5.1.1 Vapors in Ambient Air	39
5.1.2 Liquids	41
5.1.3 Sediment and Protective Soil Overburden	41

<u>SECTION</u>	<u>PAGE</u>
<b>8.0 PERSONAL PROTECTIVE EQUIPMENT</b>	<b>69</b>
8.1 General	69
8.1.1 Upgrading/Downgrading	70
8.2 Description of Levels of Protection	70
8.3 Equipment for Levels of Protection	71
8.3.1 Specified Equipment Levels	72
8.4 Special Protective Area/Operations	72
8.5 Protective Equipment for Visitors and Inspectors	76
8.6 Action Levels for Protection Levels	77
8.6.1 Particular Levels	78
8.6.2 Organic Vapor Levels	79
8.7 Justification of Action Levels	81
<b>9.0 DECONTAMINATION</b>	<b>81</b>
9.1 Personnel in Charge	81
9.2 Decontamination Facilities	83
9.3 Personal Decontamination	83
9.3.1 Exit Contamination Reduction Zone	83
9.3.2 Respirator Change or Break	84
9.3.3 Pick Up/Drop Off Tools	85
9.3.4 Emergency Decontamination	85
9.3.5 Sanitizing Protective Clothing	85
9.4 Equipment Decontamination	85
9.4.1 Personal Protective Equipment Decontamination	87
9.4.2 Monitoring Equipment Decontamination	87
9.4.3 Heavy Equipment Decontamination	88
9.5 Cleaning of Decontamination Area	88
9.6 Disposal of Contaminated Fluids and Materials	89
<b>10.0 AIR MONITORING</b>	<b>90</b>
10.1 General	90
10.2 Personnel Qualifications	90
10.3 Objectives	91
10.4 Instrumentation	92
10.4.1 Flame Ionization Detector	93
10.4.2 Photoionization Detector	94
10.4.3 Respirable Dust Monitor	94
10.4.4 Tri-Level Detector	95
10.4.5 Radiation Detector	95
10.4.6 Gas and Vapor Monitor	95
10.4.7 Sampling Pumps	95
10.4.8 PAB and SAB Tubes	96
10.5 Meteorological Monitoring	96
<b>11.0 MEDICAL SURVEILLANCE</b>	<b>96</b>
11.1 Medical Examinations	96
11.1.1 Initial Examination	98
11.1.2 Annual Examination	101

<u>SECTION</u>	<u>PAGE</u>
15.0 REFERENCES	134
15.1 Health and Safety	134
15.2 Physical/Chemical Data References	134
15.3 Other References	135
15.4 Previous Studies	135

Note: Reference numbers are indicated by ( ) throughout the document.

#### LIST OF FIGURES

2.1 Staff Organizational Chart	5
3.1 Vicinity Map	14
3.2 Location Map	15
3.3 Windrose	19
9.1 Decontamination Layout	86
13.1 Emergency Alarms	115
13.2 Fire Station Location	117
13.3 Hospital Locations	122

#### LIST OF TABLES

3.1 Weather Data	18
4.1 Hazardous Waste Characteristics	30
4.2 Selected Chemical Agent TWAs	31
5.1 Vapor Organics Identified at Basin F	36
5.2 Analysis of Basin F Liquids	40
5.3 Analysis of Basin F Bottoms	42
5.4 Analysis of Soils Underlying Basin F	43
8.1 Personal Protective Equipment	73
8.2 Specified Equipment Levels	74
13.1 On-Site Emergency Equipment	119
13.2 Emergency Phone Numbers	120

#### LIST OF APPENDICES

A - Hazard Assessment
B - Odor Properties
C - Chemical Data
D - Chemical Agent Response Guidelines
E - Forms
F - Personal Protective Equipment Instructions
G - Medical Surveillance Certificates
H - Employee Training Certificates
I - TLV Data
J - Site Safety Personal Resumes
K - Chapter 5 (Medical Program) of "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities"
M - 29 CFR Part 1910
N - Heat/Cold Stress Monitoring

#### LIST OF ATTACHMENTS

1 - Site Specific Air Monitoring Plan
---------------------------------------

## APPROVALS

By their signature, following, the undersigned certify that this Site Specific Safety Plan will be utilized for the protection of the health and safety of workers at Rocky Mountain Arsenal.

### CONTRACTOR

Corporate Health and Safety  
Officer

\_\_\_\_\_  
Name

\_\_\_\_\_  
Date

\_\_\_\_\_  
Name

\_\_\_\_\_  
Date

Project Manager

\_\_\_\_\_  
Name

\_\_\_\_\_  
Date

Site Health and Safety  
Officer

\_\_\_\_\_  
Name

\_\_\_\_\_  
Date

Department Manager

\_\_\_\_\_  
Name

\_\_\_\_\_  
Date

### SUBCONTRACTOR

\_\_\_\_\_  
Affiliation

\_\_\_\_\_  
Function/Name

\_\_\_\_\_  
Date

\_\_\_\_\_  
Affiliation

\_\_\_\_\_  
Function/Name

\_\_\_\_\_  
Date

\_\_\_\_\_  
Affiliation

\_\_\_\_\_  
Function/Name

\_\_\_\_\_  
Date

\_\_\_\_\_  
Affiliation

\_\_\_\_\_  
Function/Name

\_\_\_\_\_  
Date

### CORPS OF ENGINEERS

Project Manager

\_\_\_\_\_  
Name

\_\_\_\_\_  
Date

Industrial Hygienist

\_\_\_\_\_  
Name

\_\_\_\_\_  
Date

## 1.0 GENERAL INFORMATION

### 1.1 Introduction

This Site Specific Safety Plan (SSSP) presents the minimum health, safety, and emergency response requirements to be followed during all activities involved with the interim remediation actions at Basin F, located at the Rocky Mountain Arsenal. These activities will involve handling hazardous and toxic materials, thus requiring strict adherence to this plan.

#### 1.1.1 Adherence to the Safety Plan

All persons on-site must be familiar with the instructions and information contained in this Site Specific Safety Plan. All persons directly involved with the remediation activities must read this plan and sign a statement to the effect that they have read and understood this plan prior to site entry. THE INFORMATION CONTAINED IN THIS SITE SPECIFIC SAFETY PLAN WILL BE ADHERED TO AT ALL TIMES. Any modifications made will be presented to the team during a safety briefing and documented on forms found in Appendix E.

#### 1.1.2 Availability of the Safety Plan

The Site Specific Safety Plan shall be available on the site for inspection by all employees, their designated representatives, Corps of Engineers and OSHA personnel.

Location: Rocky Mountain Arsenal

Commerce City, Colorado

The Contractor will complete the following information:

Date Prepared:

Prepared by: (Name and Phone)

COE Construction Contract Number:

Reviewed by: (Name and Phone)

Project Manager: (Name and Phone)

Corporate Address:

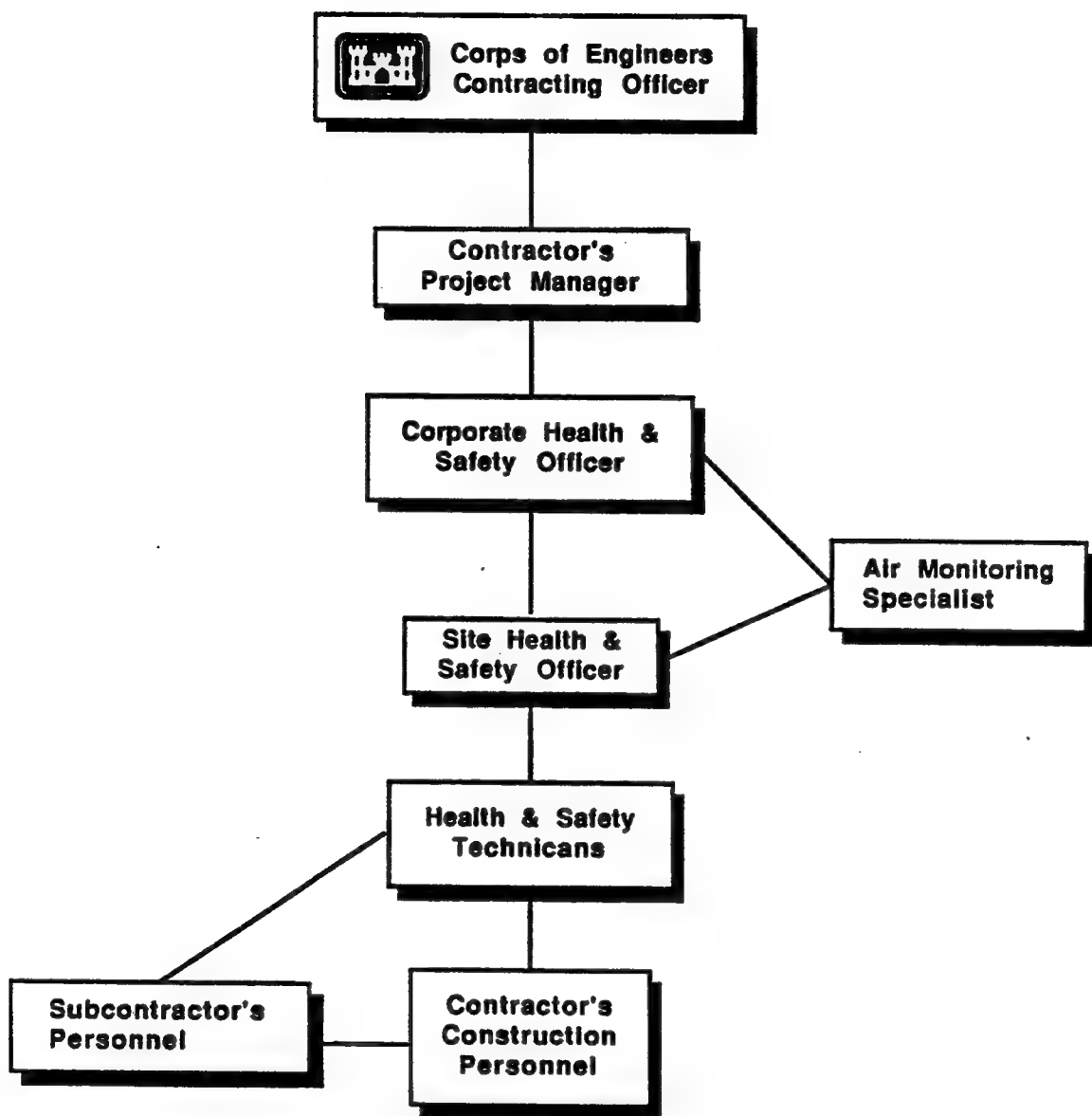
Corporate Health & Safety Officer: (Name and Phone)

Site Health & Safety Officer: (Name and Phone)

### 1.3 Regulations and Guidelines

The SSSP and all activities to be conducted at the Basin F site are, or will be, in compliance with the appropriate requirements of the following documents:

- U.S. Department of Labor OSHA Standards, Subpart H of 29 CFR (Code of Federal Regulations) Part 1910, 1910.120, December 19, 1986.
- U.S. Army Corps of Engineers, Safety and Health Requirements Manual, EM 385-1-1, October, 1984.
- Standard Operating Safety Guidelines, EPA, November, 1984.
- Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. NIOSH/OSHA/USCG/EPA, October, 1985.



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**Basin F - Interim Remedial Action  
Staff Organizational Chart  
Figure 2.1**



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Air Monitoring Specialist  
Equipment Operators  
Contract Compliance Field Engineer  
Others  
Visitors

## 2.2 Corporate Health and Safety Officer (CHSO)

The corporate health and safety officer (CHSO) shall direct the implementation of the health and safety program. The responsibilities of the CHSO include the following:

- Act as primary contact for health and safety matters between the Corps of Engineers and the construction contractor.
- Perform field inspections of health and safety related operations to check conformance with this plan.
- Investigate reports of incidents or accidents and officially report findings.
- Assist in site-specific training if necessary (i.e., additional training to meet minimum OSHA requirements).
- Provide industrial hygiene/chemical safety guidance to SHSO.
- Develop any new safety protocols and procedures necessary for new field operations.
- Resolve major outstanding health and safety issues which arise during field operations.
- Provide internal review and approval of health and safety plans.
- Audit key aspects of health and safety program.

The authority of the CHSO shall include the following:

- Approve the health and safety qualifications of employees to fill designated roles on-site.
- Approve project health and safety plans.



- Supervise compliance with health and safety requirements and enforce disciplinary actions when unsafe practices occur.

The authority of the on-site project manager shall include the following:

- Determination of matters relating to schedule, cost and personnel assignments that are not safety related.
- Temporary suspension of field activities, if health and safety of personnel are endangered, pending an evaluation by the CHSO.
- Temporary suspension of an individual from field activities for infractions of this plan, pending an evaluation by the SHSO and CHSO.

The on-site project manager shall have completed the minimum training requirements for on-site managers and supervisors presented in Chapter 12.

#### 2.4 Site Health and Safety Officer (SHSO)

The site health and safety officer (SHSO) shall be responsible for the proper implementation of this plan in the field. The responsibilities of the SHSO include the following:

- Present on-site during all field activities to enforce compliance with this plan.
- Conduct daily on-site safety briefings for all site personnel.
- Verify that communication systems are in place.
- Manage health and safety equipment (respirators, instruments, boots, gloves, suits) used at the site.
- Establish work/rest regimen in conjunction with site manager.
- Conduct emergency response provisions in conjunction with local authorities (hospital, fire, police).

## 2.5 Health and Safety Technicians

The health and safety technicians shall provide assistance to the SHSO in implementing this plan. The responsibilities of the health and safety technicians include the following.

- Provide on-site air monitoring during field activities.
- Audit safety practices utilized by on-site teams.
- Communicate with Command Post for on-site activities.
- Set up and maintain decontamination facility.
- Maintain inventory of health and safety equipment.
- Assist in decontamination, monitoring workers for heat or cold stress, and distribution of health and safety equipment.
- Initiate appropriate emergency procedures.

The health and safety technicians shall have the authority to stop work in case of an imminent safety hazard or potentially dangerous situation. After stopping work, the health and safety technicians shall immediately consult the SHSO.

The health and safety technicians shall have completed the minimum training requirements for site workers presented in Chapter 12. In addition, the health and safety technicians shall hold current CPR and First Aid certification.

## 2.6 Air Monitoring Specialist

The air monitoring specialist shall perform required air monitoring operations, as specified in the Air Monitoring Plan.

purposes, such as, agriculture, light industrial, manufacturing, and residential dwellings. The RMA remains operational, however, discharges are no longer transferred to Basin F. The Basin is located in the north central portion of Chapter 26, Township 2 South, Range 67 West. The location is shown in Figure 3.1, Vicinity Map, and more specifically in Figure 3.2, Location Map.

### 3.2 Site Description

#### 3.2.1 RMA Access

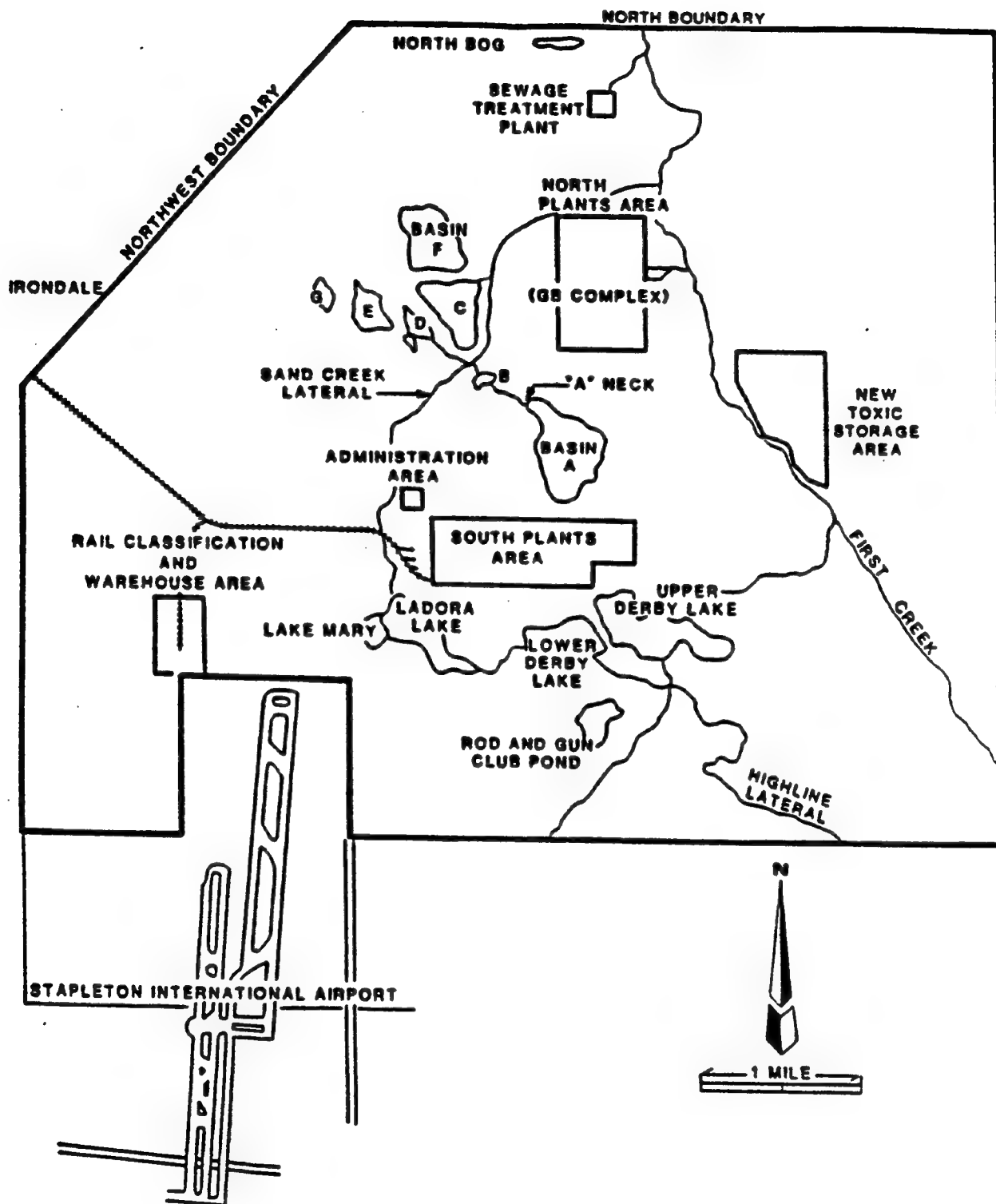
The Rocky Mountain Arsenal (RMA) is completely fenced, and access is restricted to only authorized personnel. Authorization must be obtained in advance from the RMA to be allowed on-site.

#### 3.2.2 Perimeter Identification

Access to Basin F is also restricted by a chain-link fence surrounding the lagoon area. During this remediation effort the area within the fence and adjacent areas (see Chapter 7.0) will be considered to be the Basin F Site. Additional information of site areas and work zones is provided in Chapter 7.0.

#### 3.2.3 Topography

Basin F was constructed in a natural depression in a generally flat area where the surface elevation decreases to the northwest.



Source: RMA Contamination Control Program Management Team, 1983.



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### Basin F - Interim Remedial Action Basin F Site Location Map Figure 3.2



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### 3.2.6 Status of Site

Since 1981 no wastes have been discharged to Basin F. Due to evaporation it is estimated that approximately 4 million gallons of liquid waste remain on site.

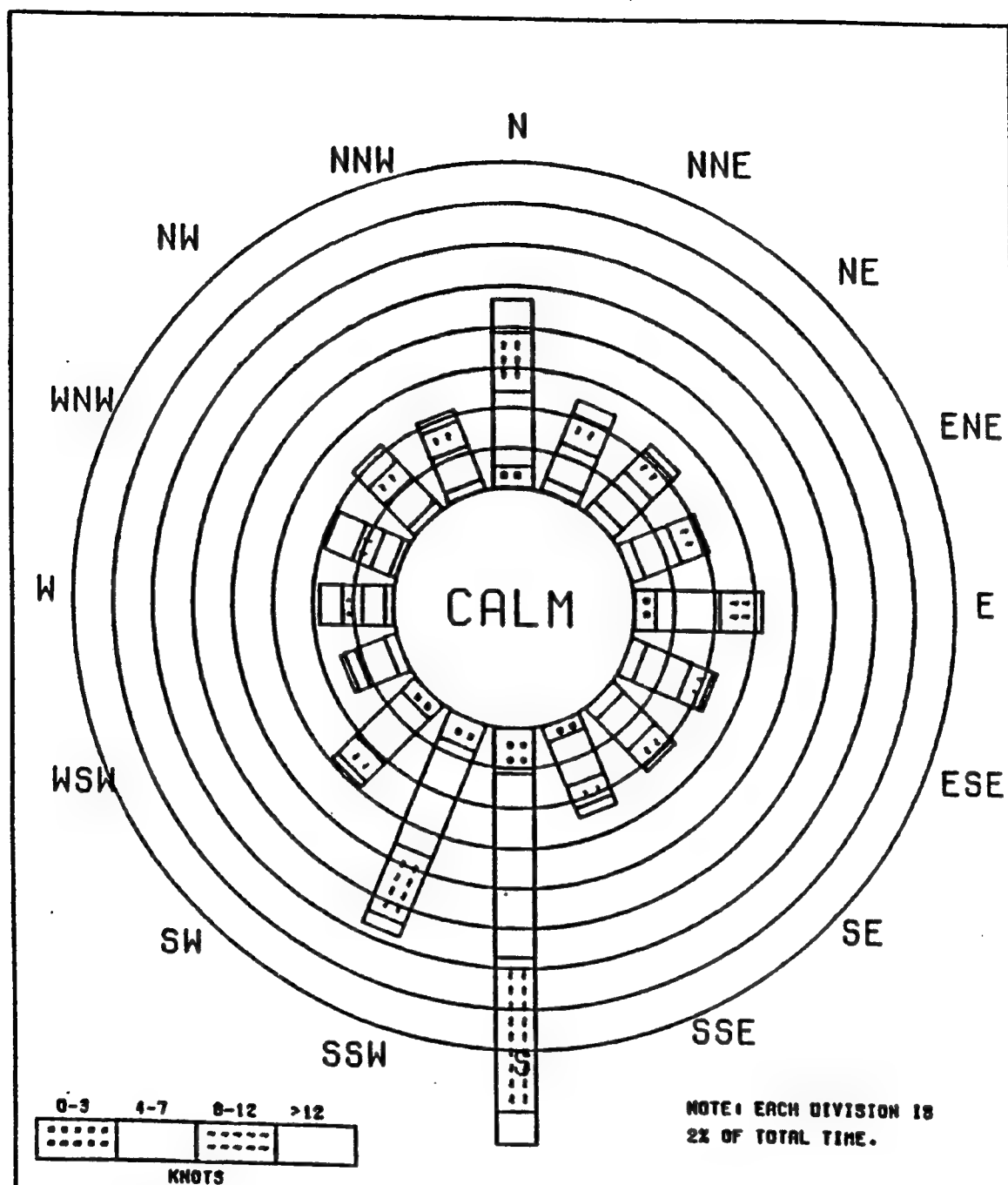
### 3.2.7 Expected Weather Conditions

Expected weather conditions will vary accordingly to the period in which the work will be conducted. Sunshine consistently averages about 70 percent of the total possible. Winds are primarily out of the South, or Southwest the entire year. Table 3.1 presents the average temperatures and associated weather data for the Denver area. A wind rose for the area is included in Figure 3.3.

## 3.3 Site History

### 3.3.1 Basin Details

Basin F was constructed in 1956 by constructing dikes around a natural depression. The Basin was constructed to serve as an evaporation basin for disposal of liquid chemical wastes. During construction of the basin, the bottom was compacted to provide a stable foundation for a liner. The asphalt liner was constructed using several applications of asphalt via a spray device. The completed liner thickness was approximately 3/8 of an inch. Following construction of the liner a 1-foot



U.S. ARMY ENVIRONMENTAL  
HYGIENE AGENCY

HEALTH SERVICES COMMAND

FIGURE ROCKY MOUNTAIN ARSENAL, CO.

PERIOD OF RECORD

JANUARY 1966 - DECEMBER 1976

SOURCE OF DATA

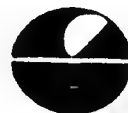
USAFETAC FOR STAPLETON AP, DENVER, CO.

Note: 1 Knot = 1.151 mph



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Basin F - Interim Remedial Action  
Annual Wind Rose [14]  
Figure 3.3



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in 1965 due to a marked increase in seismic activity in the Denver area.

From 1978 to December 31, 1981, when the basin was closed, the flow to the basin was comprised primarily of approximately 300,000 gallons per year from a hydrazine blending facility, miscellaneous Army operations, and groundwater infiltrating into the influent sewer line.

In 1982 an enhanced evaporation system was constructed. This system consisted of a new dike in the basin, a pumping system, and trickle piping along the dikes. The liquid is pumped from the basin to the trickle piping, then flows down the dike and over the exposed basin bottom to enhance the evaporation process. The evaporation process has slowed in recent years due to the concentrating of salts in the remaining liquid. It is estimated that approximately 4 million gallons remain in the basin (15,17).

### 3.3.3 Previous Remedial Actions (17)

Since construction of Basin F in 1956 a number of remediation efforts have been proposed, some of which have been implemented. The implemented efforts include:

- April 1957: Waves generated by 50 mph winds damaged the basin liner. A portion of the liquids were

determined that the complete Phase I investigation was not necessary.

- 1978: The Basin F Industrial Survey was completed, with the objective of determining industry interest in performing the cleanup of Basin F, evaluating technologies, determination of the recovery value of Basin F contents, and identification legal and environmental impacts related to cleanup operations. The project resulted in the identification of major engineering processes which could be utilized; including, incineration, concentration, enhanced evaporation, wet air oxidation, encapsulation, landfilling, and basin containment. Several projects were performed and other aspects of Basin F cleanup discussed. The following projects were either directly or indirectly related to the Industrial Survey and the cleanup of Basin F.
  - 1978: Wet air oxidation and electro-oxidation processes for removing organics, and a test plan for fluoride removal from Basin F liquid were evaluated. Findings revealed that these processes are inoperable in high electrolyte solutions such as in Basin F liquids.
  - 1979: A Chemical Assessment and Survey of Basin F was completed, which included collection of 40



- Construction of a bentonite clay cap over Basin F after the Basin and underlying strata are essentially dry.

This program was developed, studied, revised, and evaluated from 1978 until portions of it were scrapped in 1981. Geotechnical investigations had revealed areas of highly permeable bedrock beneath the Basin which seriously jeopardized the technical feasibility of the project. The scope of the project was changed significantly in August 1981 with the development of the Resource Conservation and Recovery Act (RCRA) Closure Plan. The revised plan included:

- Construction of a dike to prevent surface water runoff from entering the Basin;
- Removal of the chemical sewer line which carried wastes to the Basin; and
- Enhanced evaporation of the Basin F liquid.

These portions of the project are being carried on to completion. In addition the RCRA Closure Plan included:

- Absorption of remaining liquid in the Basin after enhanced evaporation;

Basin F back to the South Plants area and construction of a dike through the basin to reduce surface water runoff into the existing pool.

- September 1984: Recommendation was made to design and construct a waste pile facility to contain hazardous wastes from Basin F.

An enhanced evaporation system was installed at Basin F, which includes a newly constructed dike intended to reduce surface area and a large pump and pipe network for liquid distribution.

#### 3.4 Rocky Mountain Arsenal (RMA) History (16)

The RMA site is located on land previously used for agriculture. The land was purchased in 1942 by the government, and served primarily as a manufacturing facility. The RMA manufactured primarily mustard, lewisite and incendiary bombs during World War II, however, arsenious chloride and chlorine gas were also produced. From 1945-1950 the RMA distilled all available stocks of leveisite mustard and demilitarized several million rounds of mustard-filled shells.

A portion of the South Plants facilities were leased to the Colorado Fuel and Iron Corporation (CF&I) in 1947, and manufactured chlorinated benzenes and DDT. In 1949 the Julius Hyman Company assumed control of the facilities, producing insecticides. This facility was taken over in 1952 by Shell

liquid and soils surrounding the lagoon. Specific identified compounds are listed in Appendix C.

#### 4.1 Types

Types of contaminated materials may include liquid, solid (soil), sludge (lagoon bottoms), gas (volatilization), and semisolid.

#### 4.2 Containment

The majority of the waste is contained in a thin asphalt-lined lagoon which has been bermed. This interim remedial effort is for the lagoon area and liquids only.

#### 4.3 Chemical and Toxicological Characteristics

Chemical and toxicological information gathered from previous investigation efforts (RMA, Procedure Manual to the Technical Plan, Aug. 1986, Contract No. DAAK11-84-D-0017) have been included in Table 4.1 and 4.2. Additional information will be available when the laboratory bench scale testing and off-gassing testing is completed by Woodward Clyde Consultants. See Chapter 5.0, Suspected Hazards and Assessments for detailed information.

TABLE 4.2

## SELECTED CHEMICAL AGENT TLVs

Chemical <sup>a</sup> Agent	Army TLVs	Other Source TLV/TLVs
1) Mustard	(a) 0.4 mg/m <sup>3</sup> Maximum Exposure Level (b) 0.01 mg/m <sup>3</sup> for single 3 Hour Period (c) 0.003 mg/m <sup>3</sup> for single 8 Hour Period (d) 0.003 mg/m <sup>3</sup> for any 8 Hour Exposure Period Averaged Over 5 or More Consecutive Work Days	
2) H (Levinstein Mustard)	0.003 mg/m <sup>3</sup>	
3) HD (Distilled Mustard)	0.003 mg/m <sup>3</sup>	
4) Lewisite (L)	0.0001 mg/m <sup>3</sup> (ceiling)	
5) DXPO	30 mg/m <sup>3</sup>	
6) Phosgene (carbonyl chloride)	0.4 mg/m <sup>3</sup>	(a) 0.1 ppm (OSHA) (b) 0.1 ppm (ACGIH) (c) 0.1 ppm (NIOSH) (d) 0.2 ppm (NIOSH 15 minute ceiling)  0.3 mg/m <sup>3</sup> (ACGIH)  (a) 0.1 mg/m <sup>3</sup> (OSHA) (b) 0.1 mg/m <sup>3</sup> (ACGIH)
7) Cyanogen Chloride (CK)	0.6 mg/m <sup>3</sup> (ceiling)	
8) White Phosphorus		
9) Soman (GD)	0.0003 mg/m <sup>3</sup>	
10) Sarin (GB)	0.0001 mg/m <sup>3</sup>	
11) Hydrazine	-	0.1 ppm (ACGIH) 0.04 mg/m <sup>3</sup> (NIOSH 2 hr ceiling)
12) Monomethyl Hydrazine	-	0.2 ppm (ACGIH) 0.08 mg/m <sup>3</sup> (NIOSH 2 hr ceiling)
13) Unsymmetrical Dimethyl Hydrazine	-	0.5 ppm (ACGIH) 0.15 mg/m <sup>3</sup> (NIOSH 2 hr ceiling)
14) N-Nitrosodimethylamine	-	No Exposure

<sup>a</sup> Other Chemical Agents will be listed as more information is made available.

of an acute exposure may be completely different from those resulting from chronic exposure.

For either chronic or acute exposure, the toxic effect may be temporary and reversible, or may be permanent (disability or death). Some chemicals may cause obvious symptoms such as burning, coughing, nausea, tearing eyes, or rashes. Other chemicals may cause health damage without any such warning signs (this is a particular concern for chronic exposures to low concentrations). Health effects such as cancer or respiratory disease may not become manifest for several years or decades after exposure. In addition, some toxic chemicals may be colorless and/or odorless, may dull the sense of smell, or may not produce any immediate or obvious physiological sensations. Thus, a worker's senses or feelings cannot be relied upon in all cases to warn of potential toxic exposure.

The effects of exposure not only depend on the chemical, its concentration, route of entry, and duration of exposure, but may also be influenced by personal factors such as the individual's smoking habits, alcohol consumption, medication use, nutrition, age, and sex.

An important exposure route of concern at the site is inhalation. The lungs are extremely vulnerable to chemical agents. Even substances that do not directly affect the lungs may pass through lung tissue into the bloodstream, where they are transported to other vulnerable areas of the body. Some toxic chemicals present in the atmosphere may not be detected

is unlikely, however, personal habits such as chewing gum or tobacco, drinking, eating, smoking cigarettes, and applying cosmetics on site may provide a route of entry for chemicals. It is for this reason that use of these items is not allowed on-site.

The last primary route of chemical exposure is injection, whereby chemicals are introduced into the body through puncture wounds (for example, by stepping or tripping and falling onto contaminated sharp objects). Wearing safety shoes, avoiding physical hazards, and taking common sense precautions are important protective measures against injection (3).

#### 5.1.1 Contaminants in Ambient Air

A number of organic contaminants are present in the ambient air at Basin F. In a study conducted by the U.S. Army Environmental Hygiene Agency (14), thirteen target compounds were measured. Table 5.1 lists 31 organic compounds identified at Basin F, and the basis for selection of the 13 target compounds. Three of these were chosen for their potential for human toxicity. These three; dieldrin, aldrin, and hexachlorobutadiene, are suspected carcinogens. Levels of these target compounds, as measured at Basin F, were several orders of magnitude below the levels considered as safe for acute and noncarcinogenic effects. Activities at the site may significantly increase the concentrations of these contaminants.

11. (Chloroacetophenone) 1-(2-Chlorophenyl) Ethanone	C <sub>8</sub> H <sub>7</sub> OC <sub>1</sub>	C <sub>1</sub> C <sub>6</sub> H <sub>4</sub> COCH <sub>3</sub>	No	
12. Acetamide	C <sub>2</sub> H <sub>5</sub> NO	CH <sub>3</sub> CONH <sub>2</sub>	No	
13. Benzaldehyde	C <sub>7</sub> H <sub>6</sub> O	C <sub>6</sub> H <sub>5</sub> CHO	No	
14. Benzonitrile	C <sub>7</sub> H <sub>5</sub> N	C <sub>6</sub> H <sub>5</sub> CN	No	
15. Nitromethane	CH <sub>3</sub> NO <sub>2</sub>	CH <sub>3</sub> Cl	No	
16. Chloromethane	CH <sub>3</sub> Cl	CH <sub>3</sub> Cl	No	
17. Benzene Methanol, -Methyl	C <sub>6</sub> H <sub>10</sub> O	C <sub>6</sub> H <sub>5</sub> CH(CH <sub>3</sub> )OH	No	
18. 1,4-Dithiane	C <sub>4</sub> H <sub>8</sub> S <sub>2</sub>	C <sub>4</sub> H <sub>2</sub> S <sub>2</sub>	No	
19. Dimethyl Trisulfide	C <sub>2</sub> H <sub>6</sub> S <sub>3</sub>	CH <sub>3</sub> SSSCH <sub>3</sub>	No	
20. Acetic Acid, Phenyl Methyl Ester	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> O <sub>2</sub> CCH <sub>3</sub>	No	
21. Chlorobenzonitrile	C <sub>7</sub> H <sub>4</sub> NC <sub>1</sub>	C <sub>1</sub> C <sub>6</sub> H <sub>4</sub> CN	No	
22. 1-Chloro-4-(Methyl- sulfonyl) Benzene	C <sub>7</sub> H <sub>7</sub> SO <sub>2</sub> Cl	C <sub>1</sub> C <sub>6</sub> H <sub>4</sub> SO <sub>2</sub> CH <sub>3</sub>	Yes	Highest Basins F Constituent
23. Diisopropyl Methyl Phosphonate	C <sub>7</sub> H <sub>17</sub> PO <sub>3</sub>	CH <sub>3</sub> P(O)(OC <sub>3</sub> H <sub>7</sub> ) <sub>2</sub>	No	
24. Phosphoric Acid, Triethyl Ester	C <sub>6</sub> H <sub>15</sub> PO <sub>4</sub>	(C <sub>2</sub> H <sub>5</sub> O) <sub>3</sub> P(O)	No	
25. Bicyclo(2.2.1) Hepta-2,5-diene, 1,2,3,4,7,7-Hexachloro	C <sub>7</sub> H <sub>2</sub> Cl <sub>6</sub>	--	Yes	Toxicity

### 5.1.2 Liquids

Analytical analysis of Basin F liquids has indicated that the liquid is relatively homogeneous throughout the basin, and is comprised primarily of inorganic salts. A number of organic compounds have also been identified. These include, but are not limited to the following (17):

- Diisopropylmethylphosphonate (DIMP)
- Dimethylmethylphosphonate (DMMP)
- Trimethylphosphate (TMP)
- p-chlorophenylmethyloxide
- p-chlorophenylmethylsulfone
- Dithiane
- Oxathiane
- Dicyclopentadiene (DCPD)
- Aldrin
- Endrin
- Dieldrin
- Isodrin
- pp'DDT
- pp'DDE

A summary of analytical results obtained on the Basin F liquids is presented in Table 5.2. See Appendix A for detailed information on the compounds listed above.



#### 5.1.3 Sediment and Protective Soil Overburden

Unlike the liquids from Basin F, the sediment and protective soil overburden are not homogeneous in nature. The bottoms have high levels of copper, iron, and chlorinated hydrocarbons, particularly aldrin (17). An analysis of the Basin F bottom is presented in Table 5.3.

#### 5.1.4 Soils

The soils underlying the asphalt liner did not contain significant contamination in areas where the integrity of the liner was maintained. In areas where the liner has been breached, contaminants have migrated to the underlying soils. In these areas high concentrations of pesticides, DBCP, DCPD, chlorinated solvents, aromatics, as well as a number of additional organic and inorganic compounds. The deepest migration of contaminants is on the eastern side of the basin (17). An analysis summary of the underlying soils is presented in Table 5.4.

#### 5.1.5 Additional Information

Additional information on contaminants which may be present on the Basin F site are included in Appendix C. These contaminants are associated with the Rocky Mountain Arsenal (RMA) as a whole, however, these chemicals have the potential to be located in Basin F. The hazards posed by these chemicals are briefly

TABLE 5.4  
Analysis of Soils Underlying Basin F

Constituent	Number of Detections*	Concentrations (ug/g)				ESE	MRI
		Range	Mean	Median	Standard Deviation	Detection Limit (ug/g)	Detection Limit (ug/g)
<b>Volatiles (N=40)†</b>							
Chlorobenzene	2	0.8-5	3	3	3	0.3	0.3
CHCl <sub>3</sub>	3	0.3-70	30	4	40	0.3	0.7
1,2-Dichloroethane	1	1	--	--	--	0.3	0.4
BCHO	5	2-30	9	5	10	0.3	0.8
BCHD	1	25	--	--	--	--	--
Ethylbenzene	2	1-8	5	5	5	0.3	0.4
Tetrachloroethene	7	1-40	10	10	10	0.3	0.5
Tetrachloroethane	1	25	--	--	--	--	--
Toluene	7	1-1000	400	300	400	0.3	0.3
Toluene	--	25	--	--	--	--	--
1,1,1-Trichloroethane	1	0.4	--	--	--	0.3	0.5
m-xylene	2	0.4-5	2	2	3	0.3	--
MIBK	2	0.4-1	0.7	0.7	0.4	0.5	0.4
DMS	3	2-60	30	10	30	0.3	4.0
Benzene	3	1-3	2	2	1	0.3	1.0
o,p-xylene	1	10	--	--	--	0.5	0.5
<b>Semi-Volatiles (N=40)</b>							
Aldrin	9	0.7-4000	1000	1000	1000	0.9	0.5
Dieldrin	7	100-2000	500	400	500	0.3	0.6
Endrin	7	90-900	500	400	300	0.7	4.0
DIMP	2	0.5-0.8	0.6	0.7	0.2	0.5	3.0
Isodrin	7	100-3000	1000	1000	1000	0.3	0.6
DCPD	7	30-4000	1000	600	1000	0.3	6.0
DBCP	7	0.044-8.1	2.4	0.86	3.0	0.005	0.005
PCPMS	3	6-700	400	400	400	0.3	0.3
PCPMSO	5	4-70	20	5	30	0.4	1.0
DMHP	6	3-70	20	7	30	2	3.0
PCPMSO <sub>2</sub>	14	0.5-300	30	5	70	0.3	0.4
<b>Metals (N=40)</b>							
Cadmium	1	2.0	--	--	--	0.9	0.5
Chromium	36	11-34	19	18	5.6	7.2	7.4
Copper	40	5.0-2300	85	16	370	4.8	4.9
Lead	4	18-35	24	21	7.7	17	14
Zinc	35	33-320	68	57	49	16	28
Arsenic	20	4.8-18	9.6	9.2	3.6	4.7	5.2
Mercury	1	0.08-0.08	0.08	0.08	--	0.05	0.07

\* Number of samples in which constituent was detected.

† N = Number of samples analyzed.

Reference: 17

- Use of chemicals will be limited to authorized personnel familiar with their use and associated hazards.

#### 5.2.2 Heavy Equipment Operation

- Operation of heavy equipment will be limited to personnel specifically trained for operation of that piece of equipment.
- The operator shall use the safety devices provided with the equipment, including seat belts.
- While in operation all personnel not directly required shall keep a safe distance from the equipment, preferably greater than 50 feet.
- Personnel directly involved in an activity shall avoid moving into the path of a piece of equipment, or any portion thereof. Areas blinded from the operator's vision will be avoided.
- Additional riders will not be allowed on equipment unless specifically designed for that purpose.

#### 5.2.3 Mechanical Equipment Operation

Operation of mechanical equipment presents another potential source for physical hazards. Some guidelines which shall be followed include:

- All work shall be by personnel familiar with code requirements and qualified for the class of work to be performed.
- Live parts of wiring or equipment shall be guarded to protect all persons or objects from harm.
- Electric wire or flexible cord passing through work areas shall be covered or elevated to protect it from damage by foot traffic, vehicles, sharp corners, projections, or pinching.
- Temporary power lines, switch boxes, receptacle boxes, metal cabinets, and enclosures around equipment shall be marked to indicate the maximum operating voltage.
- Patched, oil-soaked, worn or frayed electric cords or cables shall not be used.
- Portable handlamps shall be of the molded composition or other type approved for the purpose. Metal-shell, paper-lined lampholders shall not be used. Handlamps shall be equipped with a handle and a substantial guard over the bulb that is attached to the lampholder or the handle.
- Extension cords or cables shall not be fastened with staples, hung from nails, or suspended by barb wire.
- All electrical circuits shall be grounded in accordance with the NEC and the NESC unless otherwise noted in the reference manuals.

equipment ground wire. The cords shall be hard usage or extra hard usage as specified in the NEC. Approved cords may be identified by the word "outdoor" or letters "WA" on the jacket.

- Bulbs attached to festoon lighting strings and extension cords shall be protected by wire guards or equivalent unless deeply recessed in a reflector.
- Temporary wiring shall be guarded, buried, or isolated by elevation to prevent accidental contact by workers or equipment.

For a complete listing of these requirements, see the aforementioned Corps manual.

#### 5.4 Noise

Control of noise hazards shall be in accordance with Chapter 32 of the COE "Safety and Health Requirements Manual," (1) and OSHA's regulation 29 CFR Part 1910.95 (2). The hazards associated with excessive noise include:

- Workers being startled, annoyed, or distracted.
- Physical damage to the ear, pain, and temporary and/or permanent hearing loss.
- Communication interference that may increase potential hazards due to the inability to warn of danger and the proper safety precautions to be taken.

construction of the waste pile and installation of the liquid transfer pipeline. During excavation there will be two major hazards associated with the contaminants. These include: 1) increased volatilization of the volatile compounds, and 2) increased potential for exposure to the semi-volatile and non-volatile compounds due to an increase in the dust content which can potentially carry these contaminants.

In addition, there will also be the hazards commonly associated with using heavy equipment as discussed previously.

#### 5.6.3 Absorption

During absorption of the Basin F sediments and overburden, a number of hazards may be present. The hazards associated with contaminants may include: 1) enhanced volatilization of contaminants due to the addition and mixing of materials and/or chemicals with the sludges, 2) release of other gasses such as ammonia during the absorption and curing process (bench scale testing showed the release of ammonia during absorption), 3) increased dust content, leading to possible increased contaminant exposure, and also physical hazards associated with 1) heavy equipment and machinery operation and 2) if fly ash is used vision in the operating area may be impaired due to the ease in which the material goes into suspension.

## 6.2 Personal Restrictions

- The required level of personal protective equipment must be worn by all on-site personnel.
- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material is prohibited in the exclusion zone and the contamination reduction zone.
- Smoking, carrying lighters and/or matches is prohibited in the exclusion zone and the contamination reduction zone.
- No contact lenses may be worn on-site.
- No jewelry may be worn on-site, except for watches which will be disposed of if they become contaminated.
- No facial hair which interferes with a satisfactory fit of the mask-to-face seal is allowed on personnel required to wear respirators or SCBAs.
- Medicine and alcohol can potentate the effects from exposure to toxic chemicals. PRESCRIBED DRUGS SHOULD NOT BE TAKEN BY PERSONNEL ON RESPONSE OPERATIONS WHERE THE POTENTIAL FOR ABSORPTION, INHALATION, OR INGESTION OF TOXIC SUBSTANCES EXISTS UNLESS SPECIFICALLY APPROVED BY A QUALIFIED PHYSICIAN. Alcoholic beverage intake will not be allowed during breaks.
- The entire body should be thoroughly washed in the decontamination trailer after completing decontamination procedures.
- NO PERSON WILL ENTER THE EXCLUSION ZONE ALONE

## 6.3 Fire Prevention and Protection

To minimize the potential for fires, and to reduce the impact of any fire, proper fire prevention and protection procedures will be followed. These procedures are to be in accordance with the U.S. Army Corps of Engineers, Safety and Health Requirements Manual (1), specifically Chapter 12, and Chapter 13 of the manual.

- Electrical lighting shall be the only means used for artificial illumination on site, or in areas where flammable liquids, vapors, fumes, dust, or gases are present. All electrical equipment and installations shall be in accordance with the National Electrical Code for hazardous locations. Globes or lamps shall not be removed or replaced nor shall repairs be made on the electrical circuit until it has been de-energized.
- No flammable liquid with a (closed cup test) flash point below 100°F (37.7°C), shall be used for cleaning purposes in the exclusion zone.
- Equipment using flammable liquid fuel shall be shut down during refueling, servicing, or maintenance. This requirement may be waived for diesel fueled equipment serviced by a closed system with attachments designed to prevent spillage.

#### 6.3.2 Fire Protection

- Portable fire extinguishers shall be provided where needed and inspected and maintained in accordance with Appendix L (1) and NFPA 10, Portable Fire Extinguishers.
- Fire extinguishers shall be suitably placed, distinctly marked, readily accessible, and maintained in a fully charged and operable condition.



will be within 75 feet (22.86m) of each pump, dispenser, underground fill pipe opening, and lubrication or service area.

- Fire extinguisher equipment shall be provided in storage areas according to the hazard present.
- Emergency telephone numbers and reporting instructions shall be conspicuously posted.

In the event of a fire or explosion, appropriate emergency responses will be followed, as presented in Chapter 13 of this plan.

#### 6.4 Contamination/Exposure Prevention

Ways in which on-site personnel may become contaminated include:

- being splashed by contaminated liquids while sampling or handling liquids;
- coming in contact with contaminated solids or liquids;
- walking through contaminated materials, either in solid or liquid state;
- being in contact with contaminated equipment;
- being in contact with contaminated solid substances in waste piles or on the soil surface;
- sitting or kneeling on the ground.

On-site team members will avoid becoming contaminated as much as possible.

- Accumulation of flammable and combustible liquids on floors, walls, etc., is prohibited. All spills of flammable and combustible liquids shall be cleaned up immediately.
- Contractors shall provide sufficient personnel and equipment to monitor compliance with all housekeeping requirements.
- Work will not be allowed in those areas that do not comply with the requirements of this chapter.
- Contractors will inspect the work area daily for adequate housekeeping and record unsatisfactory findings on the daily inspection report.

## 6.6 Safety Meetings

### 6.6.1 Initial Health and Safety Meetings

The Site Health and Safety Officer (SHSO) and/or the Corporate Health and Safety Officer (CHSO) will give a health and safety briefing prior to initiation of work at the site. This briefing will be a duration of at least four hours and will address all of the material covered in this plan, as well as, any other pertinent information. All persons that will be entering the site should have read the Contractor's SHERP prior to this initial meeting so that any questions they have can be addressed at this time.

### 6.6.2 Daily Safety Meetings

Following the initial health and safety briefing a short daily briefing will be conducted prior to site entry. This meeting will emphasize specific concerns associated with the conditions and activities planned for the day, as well as refreshing personnel on other

## 6.9 Sanitation

Sanitation provisions at the Basin F Site must meet the minimum requirements of the OSHA regulations laid out in 29 CFR Part 1910.120 (2).

## 6.10 Work/Rest Schedule

The work-rest schedule will be dependent on weather conditions encountered and the level of protection required. The interim remedial action at Basin F is scheduled to be conducted in the fall and winter months. If adjusted temperature\* remains below 72.5 degrees F, the following work schedule is recommended for all levels of protective clothing listed in this plan:

2 hrs - work  
15 min - break  
2 hrs - work  
45 min - lunch  
2 hrs - work  
15 min - rest  
2 hrs - work

If the adjusted temperature\* exceeds 72.5 degrees F, the work-rest schedule shall be modified as follows:

<u>Adjusted Temp. (°F)*</u>	<u>(Permeable Clothing) Work Duration Prior To Break (min)</u>	<u>(Impermeable Clothing) Work Duration Prior to Break (min.)</u>
90 or Above	15	work not recommended
87.5 - 90	30	15
82.5 - 87.5	60	30
77.5 - 82.5	90	60
72.5 - 77.5	120	90

mized to only those directly involved in the activity. Those not directly involved will be outside a 30-foot radius surrounding the activity.

## 7.0 WORK ZONES

### 7.1 General Organization

Controlled zones of activities will be established at Basin F prior to any on-site construction to reduce the accidental spread of potential hazardous materials during the interim remediation from the on-site areas to the off-site areas. These zones will include the exclusion zone (also, subareas within the exclusion zone), contamination reduction zone, and the support zone (including a truck delivery zone). Each work zone shall be clearly delineated with cones, tape, or fence and posted. A diagram of the site work zones shall be included with the contractors health and safety plan. This diagram should also be posted in the support zone.

### 7.2 Exclusion Zone

The exclusion zone will include all areas within the fenced Basin F boundaries. During intrusive activities where the possibility of airborne contaminants carried off-site by wind exists, an area downwind will also be included in the exclusion zone. These areas will be determined by air monitoring, and if off-site areas need to be included, they will be marked off using temporary barriers such as barricades, traffic cones or

All persons entering any of the areas within the exclusion zone must be fully decontaminated prior to leaving the area.

#### 7.2.1 Liquid Removal Zone

The liquid removal zone will be the area set aside by the contractor and approved by the contracting officer, involving the removal of liquids from Basin F, and transferring of the liquids to the storage tanks. The layout and operations within this area will be dependent on the contractor's proposed methods of achieving this goal.

Levels of protection will be in accordance with Section 8.0 of this SSSP.

#### 7.2.2 Absorption Zone

This is the area in which the Basin F sediments and sludges will be solidified. The layout and operation will also be dependent on the methods proposed by the contractor for achieving this goal. This area will produce considerable off gassing with bench tests indicating ammonia to be the primary gas. These may be considered hazardous if not contained. This activity will most likely occur within the fenced area. The level of protection required is specified in Section 8.0.

#### 7.2.6. Chemical Storage Zone

Any potentially hazardous or flammable chemicals used during construction (i.e., fuel, solvents) shall be kept in a posted area away from potential explosion or fire hazard. This area may or may not be located within the fenced area. Levels of protection are listed in Section 8.0 for this area.

#### 7.2.7 Downwind Zone

While intrusive activities are being conducted on-site, the potential of airborne contaminants migrating off-site exists. Intrusive activities which may occur include but are not limited to digging soil, pumping liquids, and absorption. Additional air monitoring will be needed. It may also be necessary to require areas directly downwind be included in the exclusion zone. If these conditions exist the site safety officer will make the decision to restrict downwind off-site access. It will be necessary to monitor the wind speed while conducting intrusive activities. The level of protection for this area is discussed in Section 8.0.

#### 7.3 Contamination Reduction Zone

This area helps minimize the transfer of contaminants from the exclusion zone to the support zone and off-site. The contamination reduction zone acts as a buffer between the exclusion

allowed outside his cab. All windows must be up while on-site, or in the contamination reduction zone, and the appropriate levels of protection worn by the driver.

#### 7.5 Support Zone

A support zone shall be established at the site. In locating this area, accessibility, wind direction, and line of sight-to-work shall be considered. As conditions change it may be necessary to move the support zone (i.e., upwind direction, construction activities locations).

The command trailer, vehicle parking, and other support facilities are to be located in this area. A shelter shall be available for workers to provide a break/lunch area. Toilets shall also be available in this area. Water and electricity are available for hookup.

### 8.0 PERSONAL PROTECTIVE EQUIPMENT

#### 8.1 General

The selection of personal protective equipment requires a site specific evaluation of the potential nature and concentration of on-site contaminants.

The personal protective equipment and action levels established in this SSSP were based on available data to date. Additional data will be available from the Laboratory Bench Scale Testing being performed by Woodward- Clyde Consultants. Data gathered from this testing will be reviewed by a toxicologist from

be required while in Level B and Level C. Level D is basically a work uniform. Level D will be used only for off-site activities and will be used as a work uniform for off-site workers. The only exception would be the delivery truck drivers who do not get out of their cab and do not enter zones requiring protective clothing. There are numerous variations and modifications possible with each level.

### 8.3 Equipment for Levels of Protection

The equipment required for the various levels of protection expected on-site are listed below. Table 8.1 contains a summary equipment table. Operating instructions for the personal protective equipment can be found in Appendix F.

All intrusive activities to be carried out within the exclusion zone require Level B personal protective equipment (PPE). Non-intrusive activities within the exclusion zone, activities in the contamination reduction zone, and downwind off-site activities require a minimum of Level C protection. Level B may be required if air monitoring in these areas indicates contamination greater than the action levels laid out in this plan.

For specific on-site work related activities, specific levels of protections are designated in Section 8.4.



**TABLE 8.1**  
**PERSONAL PROTECTIVE EQUIPMENT**

<u>Equipment</u>	<u>Material</u>	<u>Manufacturer</u>	<u>Approval Number</u>
• Underclothing	Cotton	N/A	N/A
• Inner Coverall	Cotton	N/A	N/A
• Inner Tyvek Coverall	Polycoated	*'	N/A
• Outer Tyvek Coverall	Saranex	*'	N/A
• Inner Gloves Liners	PVC	*'	N/A
• Middle Gloves	Vinyl-long	*'	N/A
• Outer Gloves	Butyl or Neoprene	*'	N/A
• Boots	Neoprene/PVC	*'	N/A
• Boot Covers (or vinyl with spats)	"Nuke"	*'	N/A
• Hard Hat	Plastic	*'	N/A
• Goggles	Plastic	*'	N/A
• Splash Shield	Plastic	*'	N/A
• Ear Plugs	*'	*'	N/A
• Full Facepiece Respirator	N/A	*'	*'
• Cartridges (OVAG- high efficiency)	N/A	*'	*'
• SCBA	N/A	*'	*'
• Escape Mask	N/A	*'	*'

\*' Contractor to provide information

severe skin hazard; or

TABLE 8.2 (Con't.)

Level of Protection	Equipment	Protection Provided	Should Be Used When	Limiting Criteria
B (con't.)	<ul style="list-style-type: none"> <li>• Chemical-resistant inter tyvek polycoated; hooded coverall</li> <li>• Two inner and one outer chemical-resistant gloves</li> <li>• Chemical-resistant safety boots</li> <li>• Hard hat</li> <li>• Two-way radio communications</li> <li>• Ear plugs (if necessary)</li> <li>• Inner cotton coveralls</li> <li>• Disposable boot covers with spats</li> <li>• Long cotton underwear or cotton coveralls</li> <li>• Splash shield (for liquids)</li> </ul>		<ul style="list-style-type: none"> <li>- that do not meet the criteria for use of air-purifying respirators.</li> <li>• Atmosphere contains less than 19.5 percent oxygen.</li> <li>• Presence of incompletely identified vapors or gases is indicated by direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the intact skin.</li> </ul>	<ul style="list-style-type: none"> <li>• Use only when it is highly unlikely that the work being done will generate either high concentrations of vapors, gases, or particulates or splashes of material that will affect exposed skin.</li> </ul>

\*1 Tape hood of outer coverall to the respirator.

\*2 Tape tyvek legs and sleeves to boots and gloves.

officer. All levels of protection designated in Table 8.3 are also required for the above persons. All persons must be trained and have proper medical surveillance before they are allowed into the restricted areas. All persons must also be accompanied by the site safety officer or a person designated by the site safety officer.

#### **8.6 Action Levels For Protection Levels**

Selection of proper action levels is complicated by the following Basin F characteristics:

- The complex mixture of contaminants is not homogeneous nor fully characterized.
- Most identified Basin F compounds do not have established exposure limits such as TLVs or PELs.
- Most of the compounds cannot be readily monitored by direct reading instrumentation.
- Key routes of exposure for many of the Basin F compounds, particularly the pesticides, include both skin contact and inhalation.

The tank being performed will be the primary factor in determining level of protection (see Table 8.3). Upgrade from the selected levels (particularly Level C to Level B) will be based on air monitoring action levels and the decision of the CHSO. Additional information available from the bench scale testing study shall be reviewed by the CHSO prior to site work.

Ambient dust levels (upwind of the site) will vary widely depending on meteorological conditions. Careful air sampling records for total dust should be compared with the specific pesticide sampling results and meteorological conditions to improve the action level selection as the project progresses.

#### 8.6.2 Organic Vapor Levels

The organic vapors identified during the Basin F air sampling program include over thirty-one compounds (USAEHA Project No. 43-21-0230-83). The highest Basin F vapor organic was dimethyl methyl phosphonate (DMMP), a compound without an established TLV. One compound with a TLV, 2-nitropropane (TLV=10 ppm), would be a good indicator compound because of a significant vapor pressure (10 mm @ 16°C) and established analytical technique. The sampling specified in the air monitoring plan will include 2-nitropropane. A maximum concentration of 10% of the TLV is permitted at the perimeter of the Level B exclusion zone.

#### ACTION LIMITS

##### LEVEL B EXCLUSION ZONES

<u>INSTRUMENT</u>	<u>RESPONSE</u>	<u>ACTION</u>
CGI	1-10% LEL	Investigate source of combust. gas
	10-25% LEL	Remove/shut off ignition sources

Respirable Dust Monitor	Less than 1 mg/m <sup>3</sup>	Upgrade to Level C
Personal Monitoring	Greater than 10% of Target Compound	Upgrade to Level B
Ammonia	Greater than 15 ppm	Upgrade to Level C

Using real time instrumentation (HNU, OVA), a maximum of 2 ppm above background is permitted at the edge of the Level B exclusion zone and 1 ppm above background at the perimeter of Level C work zones.

#### 8.7 Justification of Action Levels

To be completed upon data review by a toxicologist based on a task by task basis.

### 9.0 DECONTAMINATION

#### 9.1 Personnel in Charge

The site health and safety officer will be in charge of decontamination. The site health and safety officer will be trained in and familiar with the steps of decontamination and will periodically inspect decontamination procedures. All personnel assisting with decontamination will be equipped with at least Level C personal protective equipment.

## 9.2 Decontamination Facilities

Equipment decontamination and personnel decontamination will be conducted in separate areas. These areas will be separated to avoid contamination of the contamination reduction zone via sprays from equipment decontamination. The location of these decontamination areas are to be shown on a site map prior to the initiation of work. Prior to leaving the site, all personnel involved in on-site activities must shower to more thoroughly decontaminate. Shower facilities will be provided in a decontamination trailer.

## 9.3 Personal Decontamination

Figure 9.1 illustrates the recommended decontamination layout for the Basin F Site. Decontamination procedures to follow in different situations are discussed below. Decontamination procedures will also be followed if a team member becomes grossly contaminated, or if the protective clothing tears.

### 9.3.1 Exit Contamination Reduction Zone

A team member departing the Contamination Reduction Zone for a break or lunch will follow this decontamination procedure.

Station 1: Segregated Equipment Drop - Drop equipment  
Level C onto plastic liner.

Station 2: Boot Cover and Outer Glove Wash/Rinse and  
Level C Removal - Remove and discard disposable boot covers in plastic bag. Wash and rinse outer gloves with detergent and tap water. Remove and deposit outer gloves in plastic

#### 9.3.3 Pick Up/Drop Off Tools

A worker leaving the Exclusion Zone to pick up or drop off tools or instruments and immediately returning will not require decontamination.

#### 9.3.4 Emergency Decontamination

If possible, gross decontamination procedures will be speedily implemented in the case of an emergency. If a life-threatening injury occurs and the injured person cannot undergo decontamination procedures without incurring additional injuries, he or she will be transported in a body bag, plastic wrap, or wrapped in a blanket. The medical facility will be informed, preferably in advance, that the injured person is on the way, and has not been decontaminated.

#### 9.3.5 Sanitizing Protective Clothing

Reusable protective clothing becomes soiled due to body oils and perspiration, and consequently must be sanitized as well as decontaminated. If practical, any nondisposable protective clothing will be machine washed after a thorough decontamination; otherwise, it will be cleaned by hand or thrown away.

#### 9.4 Equipment Decontamination

Decontamination of equipment and outer personal protective equipment (such as Saranex coveralls, boot covers and outer

gloves) will be performed using a pressurized hot water sprayer andalconox soap. All equipment will first be sprayed and scrubbed with tap water andalconox soap. The equipment will then be rinsed with tap water. If persistent contamination still exists after cleaning, based on a visual assessment, the equipment is to be discarded or left on-site for reuse.

#### 9.4.1 Personal Protective Equipment Decontamination

Certain parts of contaminated respirators, such as the harness assembly or cloth components, are difficult to decontaminate. If grossly contaminated, they will be discarded. Rubber components will be soaked in soap and water and scrubbed with a brush. Respirators will be sanitized by rinsing in a germicidal rinse followed by a clean rinse, then hanging to dry.

Each person will be responsible for decontaminating their own respirators at the end of the day, and will be thoroughly trained in respirator maintenance by the site safety officer prior to use.

#### 9.4.2 Monitoring Equipment Decontamination

All reasonable precautions will be made in order to prevent monitoring equipment from becoming contaminated. If the monitoring equipment does become contaminated, it will be carefully wiped off with a damp cloth. If grossly contaminated, the EPA regional



air cylinders, monitoring equipment, cartridges, paper towels, respirators, escape masks, rescue SCBAs, and other items needed during breaks.

The decontamination trailer will be cleaned at the end of each day along with the support trailers. The site safety officer will inspect the decontamination areas daily for cleanliness. All floors are to be mopped, showers cleaned, and cupboards stocked with necessary supplies.

A laundry service will be provided to clean the cloth inner coveralls. Personnel are required to change into fresh work uniforms daily.

#### **9.6 Disposal of Contaminated Fluids and Materials**

The decontamination pads/showers will be constructed in a manner to contain and collect all potentially contaminated water and decon fluids. The waste liquids will be transferred to the storage tanks which hold the lagoon liquids or to another holding pond for evaporation.

All solid wastes generated will be bagged, labeled, drummed, and disposed of as a hazardous material at an approved hazardous waste disposal facility.

to hazardous chemicals during the Interim Remediation Activities.

The air monitoring staff will consist of the Site Health and Safety Officer (SHSO), an Air Monitoring Specialist (AMS), and Health and Safety Technicians. These persons must meet the qualifications described in Section 2.0. The SHSO and AMS will be responsible for implementing the air monitoring and sampling plan, and all activities will be conducted under their direction. The Corporate Health and Safety Officer (CHSO) will oversee the air monitoring either directly or indirectly through the SHSO.

The technicians will carry out daily tasks as directed by the SHSO and AMS. They will be provided site specific training regarding air sampling, monitoring, instrumentation, and sample shipping procedures, and will perform such duties under the supervision of the SHSO and AMS.

### 10.3 Objectives

The objectives of air sampling for this project will be to determine the work areas generating the most significant airborne contaminants, if migration is occurring and if modified levels of protection or engineering controls are required.

A combination of on-site, perimeter and work area samples will be used to assess the potential for release of air contaminants. While the primary objective of on-site air monitoring

<u>Item</u>	<u>Use</u>
Flame Ionization Detectors	Total Organic Vapors
Photo Ionization Detectors	Total Organic Vapors
Respirable Dust Meter	Total Particulates
Tri-Level Detectors	Combustible Gases, O <sub>2</sub> , and H <sub>2</sub> S
Radmeter	Radiation
Gas and Vapor Monitor	Ammonia
Portable Air Pumps	Samples, 3 L/min
SAB Sample Tubes	Organic Capture
PAB Sample Tubes	Pesticide Capture
Portable Sampling Assembly	Sample Station

Features of the instruments are briefly discussed in the sections which follow. For selection of all instruments a number of factors need to be considered such as accuracy, mobility, potential interferences on performance, alarms, remote sensing, battery life, calibration required, explosion proofing and sampling range. The Air Monitoring Specialist will be responsible for calibrating and maintaining all air monitoring equipment.

Calibrations will be in accordance with Methods indicated in NIOSH's Manual of Analytical Methods and/or methods recommended by the equipment manufacturer. Calibrations will be conducted before and after each day's sampling. Maintenance of instrumentation will be in accordance with methods recommended by the equipment manufacturer.

#### 10.4.1 Flame Ionization Detector

The Organic Vapor Analyzer (OVA) is a highly sensitive, non-specific total hydrocarbon Flame Ionization Detector (FID). OVA's are a real-time direct-reading

#### 10.4.4 Tri-Level Detector

The Tri-Level Detector is a three-way gas detector that monitors for combustible gases, oxygen, and hydrogen sulfide. It is portable, lightweight, fully automatic, and gives a characteristic warning signal when present levels of combustible gas or deficient oxygen conditions are detected. It can detect and indicate combustible concentrations up to the lower explosive limit, hydrogen sulfide concentrations up to 60 ppm, and oxygen over a range of 0 to 25%.

#### 10.4.5 Radiation Detector

The Radmeter low level gamma scintillator detects gamma radiation from 0 to 25 mR/hr through 0 to 5,000 mR/hr in five ranges. It is a portable, light-weight instrument which is calibrated in the factory.

#### 10.4.6 Gas and Vapor Monitor

Because of the anticipated generation of Ammonia from the site activities, a portable air monitor specific to Ammonia will be used.

#### 10.4.7 Sampling Pumps

A universal constant flow area sample pumps are active sampling systems which are electrically powered to mechanically induce air movement. They are compact, portable and can be set up at a fixed location. The

- Employees who are or may be exposed to hazardous substances or health hazards at or above the established permissible exposure limits, without regard to the use of respirators, for 30 days or more a year;
- Employees who wear a respirator for 30 days or more a year;
- Employees who may have been exposed in an emergency situation to hazardous substances above the permissible exposure limits.

All medical examinations and procedures shall be performed by or under the supervision of a licensed physician familiar with occupational medicine. The employer shall provide the medical examinations and procedures to the employee without cost to the employee, without loss of pay, and at a reasonable time and place.

The employer shall provide the following information to the examining physician:

- A copy of OSHA regulations 29 CFR 1910.120 and its appendices, which is included in Appendix L;
- Section 5 of the joint OSHA/EPA/USCG/NIOSH document entitled "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," which is included in Appendix K;
- A description of the employee's duties as they relate to possible exposures;
- The employee's exposure levels or anticipated exposure levels;
- A description of any personal protective equipment used or to be used;
- Information from previous medical examinations which is not readily available to the examining physician.

The examining physician shall provide the employer with a written opinion containing the following:

Personnel Hazardous Waste Duty Record is included in Appendix E. In addition, medical and work history forms provided by the physician should be completed. Information contained on these forms should emphasize these systems: nervous, skin, lung, blood-forming, cardiovascular, gastrointestinal, genitourinary, reproductive, ear, nose, and throat.

It is recommended at a minimum that the physical examination include the following:

- Height, weight, temperature, pulse, respiration, and blood pressure;
- Head, nose, and throat;
- Eyes. Include vision tests that measure refraction, depth perception, and color vision. Vision quality is essential to safety, the accurate reading of instruments and labels, the avoidance of physical hazards, and for appropriate response to color-coded labels and signals;
- Ears. Include audiometric tests, performed at 500, 1,000 2,000, 3,000, 4,000, and 6,000 hertz (Hz) pure tone in an approved booth (see requirements listed in 29 CFR Part 1910.95, Appendix D). The integrity of the eardrum should be established since perforated eardrums can provide a route of entry for chemicals into the body;
- Chest (heart and lungs);
- Peripheral vascular system;
- Abdomen and rectum (including hernia exam);
- Spine and other components of the musculoskeletal system;
- Genitourinary system;
- Skin;

All analyses should be performed by a laboratory demonstrating satisfactory performance in an established interlaboratory testing program at least equivalent to the Centers for Disease Control (CDC) program.

#### 11.1.1 Annual Examination

Annual examinations should be conducted to allow ongoing comparison with the baseline data, which is essential in determining biological trends that may mark early signs of chronic adverse health effects. Recommended tests vary, depending on the extent of potential or actual exposure, the type of chemicals involved, the duration of the work assignment, and the individual worker's profile. It is recommended that the annual examination include the following:

- Interval medical history, focusing on changes in health status, illnesses, and possible work-related symptoms;
- Interval occupational history;
- Physical examination;
- Pulmonary function testing;
- Audiometric tests, if worker is subject to high noise exposures, or if recommended by physician;
- Vision tests to check for vision degradation;
- Blood and urine tests when indicated;
- Additional medical testing, depending on available exposure information, medical history, and examination results. Testing should be specific for the possible medical effects of the worker's exposure.

## 11.2 Subcontractor and Visitor Medical Requirements

The following subcontractors and visitors will be subject to the medical examination requirements discussed in Section 11.1:

- Individuals who are or may be exposed to hazardous substances or health hazards at or above the established permissible exposure limits, without regard to the use of respirators, for 30 days or more a year;
- Individuals who wear a respirator for 30 days or more a year;
- Individuals who may have been exposed in an emergency situation to hazardous substances above the permissible exposure limits.

As discussed in detail in Section 11.1, the employer shall be responsible for the costs of the medical examinations and procedures, which shall be performed by or under the supervision of a licensed physician.

## 11.3 On-Site Team Member Surveillance

The site health and safety officer will be trained in recognizing the signs of heat stress, cold exposure, and chemical exposure, and will be responsible for conducting surveillance of the team members during decontamination. Procedures for treating injuries due to heat, cold, or chemical exposure are discussed in Section 13 of this document.



skin may be slightly flushed just before frostbite occurs. The main signs of frostbite are:

- Skin changes to white or grayish-yellow;
- Pale, glossy skin.

Extremely serious injury can result from frostbite.

#### 11.3.4 Hypothermia

Death can result from being improperly exposed to cold for a long time. The victim of exposure will undergo the following:

- Sleepy and numb;
- Movement is difficult;
- Eyesight fails.

The person may stagger or fall, and will finally become unconscious.

#### 11.3.5 Chemical Exposure

Indicators for possible chemical exposure are:

- Changes in complexion, skin discoloration;
- Lack of coordination;
- Changes in demeanor;
- Excessive salivation, pupillary response;
- Change in speech pattern;
- Headaches;

Information Sheet will be retained on-site for all persons on-site (including visitors), whether or not they are subject to the medical examination requirements. Employee Exposure/Injury Incident Reports generated during on-site activities will also be retained by the site health and safety officer, and transferred to permanent employee medical records after completion of the project. A sample Emergency Information Sheet and an Employee Exposure/Injury Incident Report is included in Appendix E.

## **12.0 EMPLOYEE TRAINING**

Employee training requirements for all employees exposed to hazardous substances, health hazards, or safety hazards are intended to provide employees with the knowledge and skills necessary to perform hazardous waste clean-up operations with minimal risk to their safety and health. Employees shall not participate in field activities until they have been trained to a level required by their job function and responsibility. Trainers shall have received a level of training higher than and including the subject matter of the level of instruction that they are providing. All training and field experience shall be certified.

### **12.1 Minimum Training Requirements**

Minimum training requirements are specified in OSHA regulations 29 CFR 1910.120(e)(2), and discussed below. The level of training shall be consistent with the employee's job function and responsibilities.

G. Emergencies

1. Emergency Recognition and Prevention
2. Communications
3. Equipment
4. Evacuation Routes and Procedures
5. Emergency Response Procedure
6. Off-Site Support
7. Documentation

H. Hands-On Training

1. Donning and Doffing Respirator
2. Respirator Maintenance
3. Fit-Testing Respirator
4. Checking Out SCBA
5. Inspecting SCBA
6. Recharging SCBA Air Cylinders
7. Donning and Doffing Level B
8. Escape Mask Use
9. Wearing Levels D, C, and B
10. Using Air Monitoring Equipment

If employers can show by an employee's work experience and/or training that the employee has had initial training equivalent to the training described above, the employee shall be considered as meeting the initial training requirements.

All site workers shall also be required to receive site specific training. Information to be included in site specific training is presented in Section 12.3. The training shall be conducted by the corporate health and safety officer or the site health and safety officer.

Site workers shall receive eight hours of refresher training annually on relevant matters such as review of health hazards and use of personal protective equipment.

on-site until after the completion of this site specific training.

## 12.2 Additional Training Requirements

Training in cardiopulmonary resuscitation (CPR), first aid, and equipment operation is also required in some cases, as discussed below.

### 12.2.1 Cardiopulmonary Resuscitation (CPR) and First Aid

CPR and first aid training shall consist of certified courses in CPR and multimedia standard first aid.

Current CPR and multimedia first aid training will be required for the CHSO, SHSO and safety technicians.

### 12.2.2 Equipment Operation

Equipment operation training shall be appropriate for the types of equipment to be operated and the conditions expected at the site. All equipment operators shall have received the appropriate equipment training prior to their operating the equipment on-site.

## 12.3 Site Specific Training

Site specific training shall consist of an initial health and safety briefing on the following information:

- Names of personnel and alternates responsible for site safety and health;
- Safety, health, and other hazards present on the site;
- Use of personal protective equipment;

### 13.0 EMERGENCY RESPONSE

In an emergency the RMA fire department will generally be contacted first. The Chemical Action and Incident Control Office (CAICO) should also be contacted if an emergency occurs. The emergency response procedures presented below are subject to modification in order to be consistent with RMA plans currently being developed by CAICO.

#### 13.1 Emergency Communication

A number of communication systems will be utilized on-site to supplement normal verbal communications.

##### 13.1.1 On-Site Systems

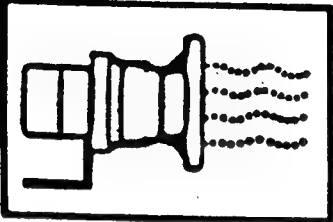
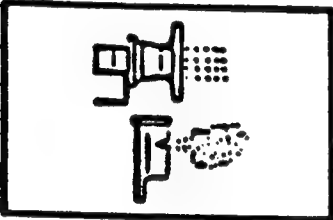
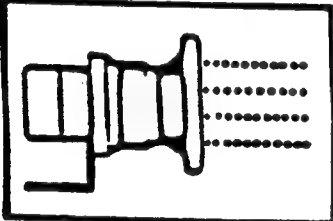
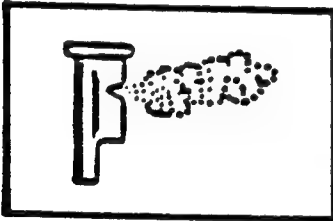
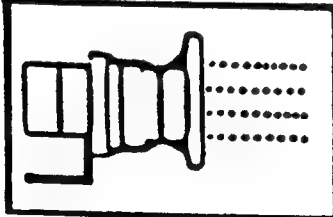
###### 1. WALKIE-TALKIES

Walkie-talkies will be utilized for communication between the site safety officer, command post in the support zone, and team members within the exclusion zone.

###### 2. FLAGS

Color-coded flags will be placed within the support area, and will be visible by all team members. The changing of the flags will be the responsibility of the safety personnel. Color coding of the flags will be as follows:

Green - normal operations.

<u>SIGNAL</u>	<u>EMERGENCY</u>	<u>ACTION</u>
	OSCILLATING SIREN 3 TO 5 MINUTE INTERVAL	ACTUAL ATTACK GO TO BLDG 732 TAKE MASK
	STEADY SIREN & INTERMITTENT WHISTLE 3 TO 5 MINUTE INTERVAL	FIRE, EXPLOSION OR TOXICANT EVACUATE PLANTS AREA UPWIND WEAR MASK
	INTERMITTENT SIREN 30 TO 45 SECOND INTERVAL	FIRE, EXPLOSION OR TOXICANT (RMA) AWAIT ADVICE
	INTERMITTENT WHISTLE 15 SECOND INTERVAL	FIRE, EXPLOSION OR TOXICANT (SCC) AWAIT ADVICE
	STEADY SIREN 3 TO 5 MINUTE INTERVAL	ALERT AWAIT ADVICE



HDR Infrastructure, Inc.  
A Centerra Company

Basin F - Interim Remedial Action  
Emergency Alarms [16]  
Figure 13.1



Woodward-Clyde Consultants



The route to the hospitals is as follows:

Presbyterian Aurora Hospital: Starting at Fire House (Bldg. 312) at corner of D Street and December 7th Avenue, proceed west on 7th to C Street (1 mile), make left on C Street (south) and go to gate (2 miles), go through gate and make left onto 56th Avenue (east, 2 miles), make right on Peoria (south), go four miles, turn left on Colfax Avenue (east) and proceed 0.9 miles. Make right by Holiday Inn onto Potomac Street before intersection with Highway 225. Proceed south 0.9 miles.

TABLE 13.1

ON-SITE EMERGENCY EQUIPMENT

Equipment	Manufacturer
Decontamination Trailer	*List specific manufacturer and model number here.
* Portable eyewash	
Water	
Stretcher	
* First Aid Kit-Industrial	
Blankets	
Oxygen Administrator	
Fire blanket	
Fire extinguisher, Type ABC 20 lb.	
* Fire extinguisher mounting bracket	
Long handled shovel	
* Two-way radio	
* Air Horn-Alert	
Absorbent Material, 10 bags	
55 gallon drums	

\* The emergency equipment must be located near all isolated work area.



Hospital is on left, on corner of Potomac Street and 6th Avenue. Emergency entrance is on south side of hospital.

Fitzsimons Hospital: Starting at Fire House (Bldg. 312) at corner of D Street and December 7th Avenue proceed west on 7th to C Street (1 mile), make left on C Street (south) and go to gate (2 miles), go through gate and make left onto 56th Avenue (east, 2 miles) make right on Peoria (south), go 3.5 miles. Hospital is on left, gate entrance is at Montview and Peoria. Enter through gate and follow orange code on-site to Emergency Center (Bldg T500).

On-site team members will conduct a trip from the site to the hospitals during the initial health and safety briefing. At that time, the site health and safety officer will record suggested improvements or clarifications to the route. The routes are shown in Figure 3.

Figures 13.2 and 13.3 will be posted at the command post, in the contamination reduction zone, and placed in the glove compartment of each on-site vehicle.

#### EMERGENCY PHONE NUMBERS:

Fire Department - (303) 289-0223  
Ambulance - (303) 289-0223  
Reed Ambulance Service - (303) 758-1333  
Airlife Helicopter - (303) 360-3250

\* These phone numbers must be updated by the Contractor

### 13.6 Personnel Injury Procedures

Procedures to be followed in the event of personnel injury are presented below. As much as practical, an on-site vehicle should not be used to transport the injured employee to the hospital. Rather, an on-site vehicle should be used to transport the individual to the site boundary, where he or she can be transferred to the emergency vehicle to be transported to

the hospital. For all injuries discussed below the SHSO shall fill out the U.S. Army Accident/Injury Report, Appendix E. A completed report shall be submitted to the Army and the corporate health and safety officer within 24 hours of the incident.

EMERGENCY PHONE NUMBERS:

Fire Department - (303) 289-0223  
Ambulance - (303) 289-0223  
RMA CAICO - (303) 289-0141  
Presbyterian Aurora Hospital - (303) 360-3133  
Rose Medical Clinic - (303) 298-0891

13.6.1 Bodily Injury

Bodily injuries which occur as a result of an accident during the operations at the site shall be handled in the following manner:

- Decontaminate victim.
- Administer first aid and/or CPR utilizing the emergency equipment on-site.
- Transport to hospital for medical attention as quickly as possible.

13.6.2 Injury Due to Heat

The main signs of heat exhaustion and heat stroke are discussed in Section 11.3.

If a person is suffering from heat exhaustion (profuse perspiration, normal body temperature), the following procedures will be undertaken:

- The victim should not smoke.
- Keep the frozen parts in warm water or covered with warm cloths for 30 minutes, even though the tissue will be very painful as it thaws.
- Elevate the injured area and protect it from injury.
- Cover the injured areas with sterile, soft, dry material.
- Keep the victim warm and get immediate medical care.
- Do not rub the frostbitten part.
- Do not allow blisters to be broken.
- Do not use ice, snow, gasoline, or anything cold on frostbite.
- Do not use heat lamps or hot water bottles to rewarm the part.
- Do not place the part near a hot stove.

First aid for improper exposure to cold consists of the following procedures:

- Decontaminate victim.
- Bring victim into a warm area as quickly as possible.
- Remove wet or cold garments.
- Dry the person thoroughly.
- Provide warm, dry clothing or covering.
- Provide rapid but gentle rewarming.
- Give victim a warm drink--not coffee, tea, or alcohol.
- Keep the victim warm and get immediate medical care.

The above fire control procedures are to be followed only with respect to containing small fires. In the event that a fire situation begins to spread rapidly, all personnel will evacuate the site until the fire department arrives.

**EMERGENCY PHONE NUMBERS:**

RMA Fire Department - (303) 289-0223  
RMA CAICO - (303) 289-0141  
RMA Safety Office - (303) 289-0338  
RMA Security Office - (303) 289-0367

**13.8 Chemical Agent Exposure Procedure**

Suspected chemical exposure shall be handled in the following manner:

- Stop all operations and evacuate area.
- Decontaminate all personnel.
- Notify RMA Fire Department, who will make all subsequent contacts (phone numbers below).
- Transport exposed individuals to hospital for medical attention as quickly as possible.
- The SHSO shall complete the Contractor Report Form Appendix E.

**EMERGENCY PHONE NUMBERS:**

RMA Fire Department - (303) 289-0223  
RMA CAICO - (303) 289-0141  
RMA Safety Office - (303) 289-0338

**13.9 Discovery of Unexploded Ordnance (UXO)**

If an unexploded ordnance (UXO) is discovered, operations shall be stopped immediately, and the area evacuated. The SHSO should immediately be informed of the UXO.

second tone on the RMA CAICO emergency siren. At either of these signals, on-site personnel shall evacuate and assemble at the Command Post or other safe area identified by the SHSO. The location should be upwind of the emergency situation.

On-site evacuations will be based on air monitoring readings, fires, explosions, or other life threatening conditions. A life threatening fire or explosion will be cause for an evacuation of immediate area. Air monitoring reading which exceed the level of protection of the workers will be cause for an evacuation of the immediate area.

Once the safety of all on-site personnel is established, the SHSO shall notify the RMA CAICO, RMA Fire Department, and Security by telephone of the emergency. When notifying Security, the complete situation should be described. The following information should be included in the description, if available:

- Time and location of emergency.
- Is an explosion or fire involved?
- Type of agent involved. Agent released?
- Any casualties?
- Estimated wind speed and direction.

EMERGENCY PHONE NUMBERS:

RMA CAICO	- (303) 289-0194
RMA Fire Department	- (303) 289-0223
Security	- (303) 289-0367

In the event of off-site environmental release of toxic or hazardous substances does occur, and immediate evacuation of the public is necessary, contact the Chemical Action and

- weather conditions;
- work activities, and team members for each task;
- levels of protection, including:
  - a. level originally specified;
  - b. change in levels of protection;
  - c. reason for change, and
  - d. time of change.
- hours that team is on-site, or performing certain tasks;
- if samples are taken, the following information is needed:
  - a. sampling location;
  - b. station numbers;
  - c. dates and times;
  - d. samplers name and affiliation;
  - e. preservatives used;
  - f. on-site measurement data, and
  - g. any field observations and remarks.

#### 14.2 Training Logs

Logs shall be kept on each on-site individual. The training records shall also be kept on-site, see Section 12.0. When site safety training is conducted a training log must be kept. This log will cover training for initial, visitors, and follow-up training, and will include:

- Individual's name and attendance record;
- Time allocation for the training session;
- Topics covered;

#### 14.4 Injury/Exposure Reporting

All incidents involving injury, illness, exposure, vehicle, or equipment damage (i.e., air monitoring instruments) are to be reported to and investigated by the site safety officer. See Appendix E for the reporting form. All on-site employee will be asked to complete the injury/exposure form as soon as possible after the accident has occurred.

The following guidelines are listed for reportable exposures:

- If the employee was exposed to vapors or aerosols of chemical compounds in excess of known health standards, such as the PEL, TLV-TWA, TLV-STEL, IDLH, etc., as indicated by instrument readings;
- If the employee was exposed to odors;
- If skin or eye contact occurred with a liquid or solid containing chemical compounds, either by a direct splash, or by failure of protective gear;
- If chemical compounds were ingested, or otherwise injected directly into the body;
- If any radiological exposure occurred;
- If any exposure to biohazardous agents occurred; and
- If the employee exhibits any symptoms of exposure, such as rash, headache, etc.

9. Dangerous Properties of Industrial Materials, Fifth Edition, N. Irving Sax, Van Nostrand Reinhold Company, 1979.
10. NIOSH Pocket Guide to Chemical Hazards, U.S. Department of Health and Human Services, September, 1985.

#### 15.3 Other References

11. Student Workbook for Multimedia Standard First Aid, American Red Cross, 1981.
12. Climate Normals for the U.S. (Base: 1951-1980), Data compiled by NOAA, Gale Research Co. Pub., 1983.
13. Dust Control at Hazardous Waste Sites, EPA/540/2-85/003, November, 1985.

#### 15.4 Previous Studies

14. "Evaluation of Organic Vapor Emissions, Basin F, Rocky Mountain Arsenal, Commerce City, Colorado, Parts I & II," June 1982.
15. "Closure Plan, Basin F, Rocky Mountain Arsenal," prepared for U.S. Army, by Ebasco Services Incorporated, December 1985.
16. "Rocky Mountain Arsenal Procedures Manual to the Technical Plan," August 1986, Volume III: Project Health and Safety Plan, Ebasco Services Incorporated.



# **Appendix A**

## **Hazard Assessment [16]**

# LITIGATION TECHNICAL SUPPORT AND SERVICES

## ROCKY MOUNTAIN ARSENAL

ROCKY MOUNTAIN ARSENAL

PROCEDURES MANUAL

TO THE

TECHNICAL PLAN

AUGUST 1986

CONTRACT NO. DAAK11-84-D-0017

VOLUME III: PROJECT HEALTH AND SAFETY PLAN

**EBASCO SERVICES INCORPORATED**

R.L. STOLLAR AND ASSOCIATES

CALIFORNIA ANALYTICAL LABORATORIES, INC.

UBTL INC. TECHNOS INC. GERAGHTY & MILLER, INC.

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FOR ROCKY MOUNTAIN ARSENAL CLEANUP, AMXRM-PM,  
ABERDEEN PROVING GROUND, MARYLAND 21010

DAAK11-84-D-0017

PREPARED FOR

PROGRAM MANAGER'S  
OFFICE FOR

ROCKY MOUNTAIN ARSENAL CLEANUP



## 6.0 HAZARD ASSESSMENT

### 6.1 General

The overall site hazard assessment is extremely variable and is entirely location and operation dependent. This judgement is based upon a review of the information made available at RMA (Rocky Mountain Arsenal). The hazard assessment of each location (e.g., building, drilling site, etc.) will be based on historical information, available data, and the results of any monitoring data. Pesticides, surety materials, unexploded ordnance (UXO), and a variety of product component materials may be present at many of the areas designated for investigation.

Groundwater samples previously analyzed were shown to contain pesticides, aromatic solvents and a variety of other chemicals. Soils throughout the site where spills have occurred, especially those near the lakes (i.e., upper and lower Derby Lakes, Ladora Lake and Lake Mary) and waste storage areas, are assumed to be contaminated. The structural integrity of onsite buildings to be sampled is unknown and may pose a hazard in addition to the confined space and restricted access problems which may be encountered in the buildings. Pipelines which require sampling may contain contaminated residues, liquids or gases which must be identified, located and sampled. In addition, existing manholes, tanks and vats may contain sludges, liquids or residues which must be sampled and may also contain unknown concentrations of toxic gases. These confined spaces present an additional hazard to be addressed and an extra level of safety will need to be applied. Section 8.0 identifies levels of personnel protection to be employed during the conduct of site work.

Numerous chemicals are known to have been used or manufactured in operations at RMA (see Appendix C). The spectrum of deleterious effects presented by exposure to these chemicals is extremely wide.

Phosgene and other choking agents are gaseous toxic chemical agents that, if present, would require the highest level of respiratory protection due to the extremely dangerous nature of these compounds. Due to the high volatility of phosgene, it is doubtful that residual phosgene remains in buildings. However, confined spaces should be treated with extra caution.

#### 6.2.2 Nerve Agents

"Nerve agents" are extremely toxic compounds that rapidly affect muscular coordination. Sarin is an example of a nerve agent known to have been associated with operations at the site. (Another nerve agent, VX, is very similar to Sarin but is less volatile.) Sarin is present as a liquid; exposure to its vapor also presents an extreme hazard. Specifically, nerve agent vapors may be inhaled as well as rapidly absorbed through the skin and eyes. Dermal uptake of nerve agents in liquid form is also very rapid. A lethal dose of sarin will act extremely rapidly on the autonomic nervous system and result in death immediately or delayed for up to 2 hours. Sarin and other nerve agents are considered among the most toxic chemicals known which dictates the highest degree of both respiratory and skin protection when these compounds are believed to be present.

#### 6.2.3 Blood Agents

"Blood agents" are compounds that generally are inhaled, enter the circulatory system, and interfere with blood to tissue oxygen transfer. Cyanogen chloride and hydrogen cyanide are blood agents with similar properties and mechanisms of action. Blood agents are typically highly volatile liquids. In addition, acute exposure to toxic doses results in very rapid physiological responses (e.g., lethal doses cause death within 15 minutes). While the nature of these compounds dictates the highest level of personnel respiratory protection when present, their high volatility makes onsite contamination in unconfined spaces unlikely.

airborne metal particles. A wide range of toxic effects may occur from exposure of the various metals. Due to heavy use and/or spills, the most likely heavy metals that would be encountered at the site are arsenic, mercury and lead.

Acute toxicity from arsenic exposure usually occurs via ingestion. Chronic arsenic poisoning by inhalation is of more concern for the safety of sampling personnel. A variety of systemic effects may occur from chronic exposure to arsenic compounds including damage to the liver, kidneys, blood, and nervous system. Arsenic has been implicated as a human carcinogen. The blister agent lewisite discussed above is an arsenic compound. Arsenic trichloride is another arsenical contaminant that may be present at the site.

Mercury exposure causes a wide range of acute and chronic effects. The form of mercury (elemental, inorganic, or organic) influences the toxic responses. For example, chronic exposure to inorganic mercury usually results in renal toxicity while elemental mercury affects the central nervous system. Due to the high vapor pressure of elemental mercury (which may be present onsite), inhalation would be the most important route of exposure in industrial exposures. In general, although mercury compounds may affect a number of different organs and systems, the most common toxic effects are on the central nervous system.

Like arsenic and mercury, lead is a heavy metal that produces toxic effects on a number of different organs or tissues. The most common exposure route of lead compound is by inhalation of the dusts or vapors. In addition, organic lead compounds may also be absorbed through the skin. Lead is a suspected lung and kidney carcinogen. At RMA, a primary lead contaminant may be lead azide. Unlike many other lead compounds, the hazard associated with lead azide is due more to the explosion potential rather than systemic toxicity. This is a very dangerous compound since shock and heat will cause explosions.

occupational exposures most often involve the dermal route. Endrin is an example of an insecticide that is highly toxic when absorbed through the skin. A high level of respiratory protection would usually be appropriate only when an inhalation hazard exists (such as during pesticide spraying operations).

## 6.5 Solvents

Organic solvents were associated with activities at RMA and several have been detected in groundwater samples. The major classes of solvents that were employed onsite include halogenated aliphatic hydrocarbons (e.g., chloroform, carbon tetrachloride, methylene chloride, trichloroethylene, tetrachloroethylene), aromatic hydrocarbons (benzene, toluene, xylene), and aliphatic alcohols (methanol, ethanol). While many solvents are highly volatile (e.g., ethanol, acetone), others are quite persistent in the environment (chlorinated hydrocarbons). Likewise, organic solvents span the range from practically non-toxic to very toxic.

Two of the more toxic solvents are carbon tetrachloride and chloroform. Both compounds are central nervous system depressants (causing narcotic effects or even coma). Chronic exposure to these compounds may cause liver and kidney damage. In addition, they are suspected carcinogens. As with most organic solvents, vapors result in a common route of exposure. Dermal absorption may also occur upon topical application.

Benzene is a solvent of relatively high volatility resulting in inhalation as the usual route of entry. Acute exposure to benzene results in local skin irritation, or at high concentrations, central nervous system effects (e.g., narcosis). Chronic benzene poisoning causes hematologic (blood) abnormalities and has been linked to leukemia.

In association with the hydrazine blending facility is nitrosodimethylamine (NDMA).<sup>5</sup> NDMA is an EPA and OSHA regulated carcinogen. Routes of exposure may be through inhalation or absorption through the skin. No acceptable exposure limit is recommended by OSHA.

//

REFERENCES:  
General Industry. 29CFR1910. March 11, 1983. D2949 2304.  
NIOSH Pocket Guide to Chemical Hazards. US29498. September 1985.  
Toxicity Assessment for MMS Target Contaminants. Draft Report. April 1987.

ABBREVIATIONS:

NTAP = n hour time-weighted average  
AC = acceptable ceiling  
optimal = acceptable peak for n minutes in any n hours  
TLV = threshold limit value (OTM)  
+ = designated carcinogens  
LDL = lowest detectable level



Acute tox data: Oral LD<sub>50</sub> (rat) = 3,300 mg/kg. [3]  
 THR = MOD via oral route.

**2,4,4-TRIMETHYL PENTENE-1.** See diisobutylene.

**2,3,4-TRIMETHYL-1-PENTENE.** bp: 101°, flash p: <70°F, autoign. temp.: 779°F.  
 Fire Hazard: Dangerous, via heat, flame or oxidizers.  
 To Fight Fire: Dry chemical, CO<sub>2</sub>, foam.

**2,4,4-TRIMETHYL PENTENE-2.** A clear liquid.  
 C<sub>8</sub>H<sub>16</sub>, mw: 112.2, bp: 104.5°, flash p: 35°F (TOC), fp: -106.4°, d: 0.724 @ 15.5°/15.5°, vap. press: 77.5 mm @ 38°, vap. d: 3.9, autoign. temp.: 581°F.  
 THR = U. Probably irr and narcotic in high conc.  
 See also isooctene.

Fire Hazard: Dangerous, when exposed to heat or flame.

Explosion Hazard: U.

Disaster Hazard: Highly dangerous; keep away from heat or open flame; can react vigorously with oxidizing materials.

To Fight Fire: Foam, CO<sub>2</sub>, dry chemical.

**3,4,4-TRIMETHYL-2-PENTENE.** bp: 112°, autoign. temp.: 617°F.  
 Fire Hazard: See 2,3,4-trimethyl-1-pentene.

To Fight Fire: See 2,3,4-trimethyl-1-pentene.

**1,2,4-TRIMETHYL PHENANTHRENE.**  
 1 HR = An exper carc. [23]

**TRIMETHYL PHENYL GERMANIUM.** Colorless liquid, insol in water. (CH<sub>3</sub>)<sub>3</sub>Ge(C<sub>6</sub>H<sub>5</sub>), mw: 194.8, bp: 183°.  
 THR = U. See germanium compounds.

**TRIMETHYL PHENYL METHYL CARBAMATE.**  
 See landrin.

**TRIMETHYL PHOSPHATE.** C<sub>3</sub>H<sub>9</sub>O<sub>4</sub>P, mw: 140.1.  
 Acute tox data: Oral LD<sub>50</sub> (rat) = 840 mg/kg; oral LD<sub>50</sub> (mice) = 1470 mg/kg; dermal LD<sub>50</sub> (rabbit) = 2830 mg/kg. [3]  
 THR = MOD via oral and dermal routes. An exper mutagen via ip route. [3]

**TRIMETHYL PHOSPHINE.** Colorless liquid. (CH<sub>3</sub>)<sub>3</sub>P, mw: 76.1, bp: 42°, d: <1.  
 THR = Details U. Probably HIGH. See also phosphine.

Fire Hazard: Spont flamm in air. [19] See also phosphine.

Explosion Hazard: Violent reaction in air. [19]

Disaster Hazard: Dangerous; when heated to decomp, or on contact with acid or acid fumes, emits highly toxic fumes of PO<sub>x</sub>; can react vigorously with oxidizing materials.

flash p: 130°F (OC).  
 THR = Violent reaction with Mg(ClO<sub>4</sub>)<sub>2</sub>. [19]  
 Fire Hazard: Mod, when exposed to heat, flame or oxidizers.  
 Disaster Hazard: Dangerous; see phosphates.  
 To Fight Fire: Water, foam, fog, CO<sub>2</sub>.

**TRIMETHYL RHENIUM.** Colorless oil. Re(CH<sub>3</sub>)<sub>3</sub>, mw: 231.4, bp: 60°.  
 THR = Details U. See rhenium compounds.

**N-(TRIMETHYLSILYL)AMIDAZOLE.** C<sub>4</sub>H<sub>12</sub>N<sub>2</sub>Si, mw: 140.3.  
 THR = An exper neo. [3]

**TRIMETHYL STANNYL TRIPHENYL GERMANIUM.** White crystals, insol in water. (CH<sub>3</sub>)<sub>3</sub>SnGe(C<sub>6</sub>H<sub>5</sub>)<sub>3</sub>, mw: 467.7, mp: 88°.  
 THR = Toxic. Details U. See tin and germanium compounds.

**TRIMETHYL STIBINE.** See antimony trimethyl.

**2,4,6-TRIMETHYL-1,2,3,6-TETRAHYDROBENZ-ALDEHYDE.** Liquid. C<sub>10</sub>H<sub>10</sub>O, mw: 152.23, mp: -41°, bp: 204.5°, flash p: 185°F (OC), d: 0.9195 @ 20°/20°, vap. press: 0.3 mm @ 20°, vap. d: 5.25.  
 THR = Details U. See aldehydes.

Fire Hazard: Mod, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam, CO<sub>2</sub>, dry chemical.

**TRIMETHYL THALLIUM.** (CH<sub>3</sub>)<sub>3</sub>Tl, mw: 249.5.  
 Spont flamm in air. [19]  
 THR = Toxic. See also thallium compounds.

**TRIMETHYL TIN.** Colorless liquid, insol in water.

**TRIMETHYL TIN.** Colorless liquid, insol in water. (CH<sub>3</sub>)<sub>3</sub>Sn, mw: 163.8, d: 1.570 @ 25°, mp: 23°, bp: 182°.  
 THR = See tin compounds.

**TRIMETHYL TIN ACETATE.** C<sub>3</sub>H<sub>9</sub>O<sub>2</sub>Sn, mw: 222.9.  
 Acute tox data: Oral LD<sub>50</sub> (rat) = 9 mg/kg. [3]  
 THR = VERY HIGH via oral route. See also tin compounds.

**TRIMETHYL TIN BROMIDE.** Colorless crystals, sol in water and organic solvents. (CH<sub>3</sub>)<sub>3</sub>SnBr, mw: 243.7, mp: 27°, bp: 165°.  
 THR = See tin compounds and bromides.

**TRIMETHYL TIN CHLORIDE.** Colorless crystals, sol in water and organic solvents. (CH<sub>3</sub>)<sub>3</sub>SnCl, mw: 199.3, mp: 37°.  
 THR = See tin compounds and chlorides.

**TRIMETHYL TIN FLUORIDE.** Colorless crystals, slightly sol in organic solvents. (CH<sub>3</sub>)<sub>3</sub>SnF, mw: 182.8,

sol in organic solvents.  
 60°.

THR = See tin compounds and hydri-

**TRIMETHYL TIN HYDROXIDE.** Co-

sol in water and many organic solvent  
 mw: 180.8, mp: 118° (decomp).  
 Acute tox data: sc LD<sub>50</sub> (mice) = 1.8  
 THR = VERY HIGH via sc route. H  
 and oral routes. See tin compound

**TRIMETHYL TIN IODIDE.** Colorless  
 many organic solvents. (CH<sub>3</sub>)<sub>3</sub>SnI,  
 2.1432, mp: 3.4°, bp: 170°.  
 THR = See tin compounds and iodic

**TRIMETHYL TIN OXIDE.** White f  
 water and organic solvents. (CH<sub>3</sub>)<sub>3</sub>  
 mw: 343.6.

THR = Details U. See tin compound

**TRIMETHYL TIN SULFATE.** C<sub>3</sub>H<sub>9</sub>Si  
 260.9.  
 Acute tox data: Oral LD<sub>50</sub> (rat) = 3C  
 (rat) = 16 mg/kg. [3]  
 THR = HIGH via oral and ip rou  
 compounds.

**TRIMETHYL TIN SULFIDE.** Light  
 in water, sol in organic solvents.  
 (CH<sub>3</sub>)<sub>3</sub>Sn-Sn(CH<sub>3</sub>)<sub>3</sub>, mw: 359.7,  
 mp: 6°, bp: 233.5°.  
 THR = See tin compounds and sulf

**TRIMETHYL TRIBORINE TRIAM**  
 less crystals or liquid, hydrolyzed by  
 B<sub>3</sub>(CH<sub>3</sub>)<sub>3</sub>N<sub>3</sub>H<sub>3</sub>, mw: 122.6, mp: 31.5  
 THR = Details U. See also boron  
 amines.

**TRIMETHYL TRIBORINE TRIAN**  
 less liquid, hydrolyzed by water. (C  
 122.6, bp: 134°.  
 THR = Details U. See also boron  
 amines.

**TRIMETHYL TRIBORINE TRIAM**  
 liquid, hydrolyzed by water. (C  
 122.6, bp: 139°.  
 THR = Details U. See also boron  
 amines.

**3,8,13-TRIMETHYL TRICYCLOQ**  
 C<sub>24</sub>H<sub>18</sub>N<sub>4</sub>, mw: 362.5.  
 THR = An exper neo. [3]

**α,α-TRIMETHYL-TRIMETHYL**  
 See 2-methyl-2-methanediol.

**2,4,6-TRIMETHYL-1,3,5-TRIOXA**

ility at room temperature and higher

Code Numbers: CAS 3129-91-7 RTECS HY4200000 UN 2687

DOT Designation: —

Synonyms: Dechan, di-Chan; dicyclohexylamine nitrite; dodecahydro-diphenylamine nitrite.

**Potential Exposure:** It is used as a vapor-phase corrosion inhibitor whereby it vaporizes either from the solid state or from solution and offers protection against atmospheric rusting. Wrapping paper, plastic wraps, and other materials may be impregnated with di-Chan to protect metal parts during packaging and storage.

**Permissible Exposure Limits in Air:** A maximum concentration of  $0.2 \text{ mg/m}^3$  has been recommended in the U.S.S.R.

**Permissible Concentration in Water:** No criteria set.

**Harmful Effects and Symptoms:** Prolonged exposure to dicyclohexylamine nitrite vapor is reported to lead to changes in the CNS, erythrocytes, and methemoglobinemia and to disturb the functional state of the liver and kidneys of human workers. Di-Chan is quite possibly a weakly active carcinogen in mice and rats.

**Disposal Method Suggested:** See dicyclohexylamine.

#### References

- (1) U.S. Environmental Protection Agency, *Chemical Hazard Information Profiles: Cyclohexylamine*, Washington, DC (October 21, 1977).

## DICYCLOPENTADIENE

**Description:**  $\text{C}_{10}\text{H}_{12}$  is a crystalline solid melting at  $34^\circ\text{C}$  and boiling at  $172^\circ\text{C}$ .

**Code Numbers:** CAS 77-73-6 RTECS PC1050000 UN 2048

**DOT Designation:** Flammable liquid.

**Synonyms:** Bicyclopentadiene; 1,3-cyclopentadiene dimer; 3a,4,7,7a-tetrahydro-4,7-methanoindene.

**Potential Exposures:** This compound is used in the manufacture of cyclopentadiene as a pesticide intermediate. It is used in the production of ferrocene compounds. It is used in paints and varnishes and resin manufacture.

**Permissible Exposure Limits in Air:** There is no Federal standard but ACGIH

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ays at  $75^\circ\text{C}$   
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**ALCOHOL, TERTIARY.** See specific compound.

**ALDEHYDE AMMONIA.** Syn: *acetaldehyde ammonia*. White crystalline solid.  $\text{CH}_3\text{CH}(\text{NH}_2)\text{OH}$ , mw: 61.08, bp: 110°, mp: 97°.

THR = MOD irr to skin, eyes and mu mem via oral and inhal routes.

Fire Hazard: Mod, when exposed to heat or flame; readily decomp into acetaldehyde and ammonia when heated.

Explosion Hazard: Mod, when exposed to heat or flame.

Explosive Range: See ammonia.

Disaster Hazard: Mod dangerous when heated to decomp, emits toxic fumes, can react with oxidizing materials.

**ALDEHYDE C-8.** See caprylaldehyde.

**ALDEHYDE C-16.** See ethyl methyl phenyl glycidate.

**ALDEHYDES.** See also specific compounds. All the aldehydes possess anesthetic properties, but this is obscured by their highly irr action on the eyes and mu mem of the respiratory tract. The lower aldehydes, very sol in water, act chiefly on the eyes and tissues of the upper respiratory tract. The higher aldehydes, less sol in water, tend to penetrate more deeply into the respiratory system and may affect the lungs. The above toxicity hazard rating is more accurate for the lower molecular weight aldehydes. Some higher aldehydes and also the aromatic aldehydes may exhibit much lower toxicity.

**ALDEHYDINE.** See 5-ethyl-2-methyl pyridine.

**ALDERLIN.**  $\text{C}_{15}\text{H}_{19}\text{ON}$ , mw: 229.3.

Acute tox data: Oral  $\text{LD}_{50}$  (rat) = 900 mg/kg; iv  $\text{LD}_{50}$  (rat) = 50 mg/kg; ip  $\text{LD}_{50}$  (mice) = 124 mg/kg. [3]

THR = HIGH via ip and iv routes; MOD via oral route. An exper carc to mice. [3]

**ALDOL.** Syns: *acetaldol*, *3-butanolal*, *oxybutyrylaldehyde*. Clear, white to yellow syrupy liquid.  $\text{C}_4\text{H}_8\text{O}_2$ , mw: 88.10, bp: 83° @ 20 mm, flash p: 150°F (OC), d: 1.11, autoign. temp.: 482°F, vap. d: 3.04.

THR = MOD via oral route.

Fire Hazard: Mod, when exposed to heat or flame; decomp into crotonaldehyde and water when heated. See crotonaldehyde.

Spontaneous Heating: No.

Disaster Hazard: Dangerous; when heated to decomp, emits highly toxic fumes of crotonaldehyde; can react with oxidizing materials.

To Fight Fire: Water, alcohol foam, mist or water spray,  $\text{CO}_2$ , dry chemical.

**ALDOMET.** See methyl dopa.

**ALDRIN.** Syns: *1,2,3,4,10,10-hexachloro-1,4,4a,5,8-*

*8a-hexahydro-1,4,5,8-dimethanonaphthalene, octalene, compound 118.* Crystals, insol in water, sol in aromatics, esters, ketones, paraffins and halogenated solvents.  $\text{C}_{12}\text{H}_8\text{Cl}_6$ , mw: 365, mp: 104°-105°.

Acute tox data: Oral  $\text{LD}_{50}$  (rat) = 55 mg/kg, dermal  $\text{LD}_{50}$  (rat) = > 200 mg/kg. [94]

THR = HIGH via oral, dermal and CNS routes. Ingestion, inhal or absorption of this material into the body can cause irritability, convulsions and depression in from 1 to 5 hrs. Continued exposure causes liver damage. An exper carc. [3, 12, 102] See chlorinated HC.

Disaster Hazard: Dangerous; see chlorides.

**ALFALFA MEAL.**

THR = A mild sensitizer, which when inhaled may cause asthma, running nose, sneezing, coughing and tearing eyes. Contact with skin may cause contact dermatitis.

Fire Hazard: Mod, when exposed to heat or flame; by spont chemical reaction.

Spontaneous Heating: Yes. Avoid moisture content extremes. Fires may smolder for 72 hrs before becoming noticeable.

**ALIPHATIC AMINES.** See fatty amines.

**ALIPHATIC AND AROMATIC EPOXIDES.**

THR = Exper carc of skin, lung, blood-forming tissues. [14]

**ALIPHATIC AND AROMATIC EPOXIDE MONOMERS AND POLYMERS.**

THR = Exper carc. See aliphatic and aromatic epoxides. [14]

**ALIZARIN.** Syn: *1,2-dihydroxy anthraquinone*. Orange-red crystals.  $\text{C}_{16}\text{H}_8\text{O}_4$ , mw: 240.2, bp: 430° (sublimes), mp: 289°.

THR = MILD allergen.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

**ALKALIES.** (see also specific compounds.)

A term loosely applied to the hydroxides and carbonates of the alkali metals and alkaline earth metals, as well as the bicarbonate and hydroxide of ammonium. They can neutralize acids, change the color of indicators and impart a soapy taste and feel to aqueous solutions.

THR = Variable. The alkalies, as a group, constitute the commonest causes of occupational dermatitis. They act on the skin as primary irr. Alkaline solutions soften and dissolve the keratin layer, and the skin becomes white, soggy, wrinkled and macerated. Repeated exposure frequently results in the development of chronic eczematous skin conditions. The stronger caustics may produce chemical burns

**Determination in Water:** Gas chromatography (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625).

**Routes of Entry:** Inhalation, skin absorption, ingestion and eye and skin contact.

**Harmful Effects and Symptoms:** Headaches, dizziness, nausea, vomiting, malaise, myoclonic jerks of limbs, clonic, tonic convulsions, coma, hematuria, azotemia. Aldrin and dieldrin have been the subject of litigation bearing upon the contention that these substances cause severe aquatic environmental change and are potential carcinogens. In 1970, the U.S. Department of Agriculture cancelled all registrations of these pesticides based upon a concern to limit dispersal in or on aquatic areas. In 1972, under the authority of the Fungicide, Insecticide, Rodenticide Act as amended by the Federal Pesticide Control Act of 1972, USCS Section 135, et. seq., an EPA order lifted cancellation of all registered aldrin and dieldrin for use in deep ground insertions for termite control, nursery clipping of roots and tops of nonfood plants, and mothproofing of woolen textiles and carpets where there is no effluent discharge.

In 1974, cancellation proceedings disclosed the severe hazard to human health and suspension of registration of aldrin and dieldrin use was ordered; production was restricted for all pesticide products containing aldrin or dieldrin. However, formulated products containing aldrin and dieldrin are imported from Europe each year solely for subsurface soil injection for termite control. Therefore, limits that protect all receiving water uses must be placed on aldrin and dieldrin. The litigation has produced the evidentiary basis for the Administrator's conclusions that aldrin/dieldrin are carcinogenic in mice and rats, approved the EPA's extrapolation to humans of data derived from tests on animals and affirmed the conclusions that aldrin and dieldrin pose a substantial risk of cancer to humans, which constitutes an "imminent hazard" to man (A-33).

**Points of Attack:** Central nervous system, liver, kidneys, skin.

**Medical Surveillance:** Consider the points of attack in preplacement and periodic physical examinations.

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, wash with soap immediately. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** Wear appropriate clothing to prevent any possibility of skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash immediately when skin is wet or contaminated. Work clothing should be changed daily if it is possible that clothing is contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers.

#### Respirator Selection:

2.5 mg/m<sup>3</sup>: CCROVDMPEst/SA/SCBA  
12.5 mg/m<sup>3</sup>: CCROVDFMPEst/GMOVDFMPEst/SAF/SCBAF  
100 mg/m<sup>3</sup>: SA: PD, PP, CF/CCROVHiPEst  
Escape: GMOVPEst/SCBA

**Disposal Method Suggested:** Aldrin is very stable thermally with no decomposition noted at 250°C. Aldrin (along with the structurally related compounds

dieldrin and isodrin) is remarkably stable to alkali (in contrast to chlordane heptachlor) and refluxing with aqueous or alcoholic caustic has no effect.

Incineration methods for aldrin disposal involving 1500°F, 0.5 second in mum for primary combustion, 3200°F, 1.0 second for secondary combustion with adequate scrubbing and ash disposal facilities have been recommended (A-31). The combustion of aldrin in polyethylene on a small scale gave n than 99% decomposition. Aldrin can be degraded by active metals such as sodium in alcohol (a reaction which forms the basis of the analytical method for dieldrin), but this method is not suitable for the layman.

A disposal method suggested for materials contaminated with aldrin, dieldrin or endrin consists of burying 8 to 12 feet underground in an isolated area a from water supplies, with a layer of clay, a layer of lime and a second layer of clay beneath the wastes (A-32).

#### References

- (1) U.S. Environmental Protection Agency, *Aldrin/Dieldrin: Ambient Water Quality Criteria*, Washington, DC (1979).
- (2) U.S. Environmental Protection Agency, *Aldrin*, Health and Environmental Effects Profile No. 8, Washington, DC, Office of Solid Waste (April 30, 1980).
- (3) National Cancer Institute, *Bioassays of Aldrin and Dieldrin for Possible Carcinogenicity*, Technical Report Series No. 21, Bethesda, Maryland (1978).
- (4) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 3rd Edition, Van Nostrand Reinhold Co. (1981).
- (5) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 3, No. 5, 2nd Edition, Van Nostrand Reinhold Co. (1983).
- (6) United Nations Environment Programme, *IAPTC Legal File 1983*, Vol. 1, pp VII/82, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

## ALKANES (C<sub>5</sub>-C<sub>8</sub>)

**Description:** The alkanes have the formula C<sub>n</sub>H<sub>2n+2</sub> and are colorless, flammable liquids, such as pentane, C<sub>5</sub>H<sub>12</sub>, boiling at 36.1°C and octane, C<sub>8</sub>H<sub>18</sub>, boiling at 125.6°C.

**Synonyms:** Paraffins, paraffin hydrocarbons. See also entries under hexane, heptane, octane and pentane.

**Harmful Effects and Symptoms:** Aliphatic hydrocarbons are asphyxiants and central nervous system depressants. Lower members of the series, methane and ethane, are pharmacologically less active than higher members of the series; their main hazards resulting from the simple displacement of oxygen and fire and from explosion. Higher members of the series cause narcosis. At least one member (hexane) has neurotoxic properties. Another common effect is irritation of the skin and mucous membranes of the upper respiratory tract. Prolonged and prolonged skin contact may result in dermatitis, due to the defatting of skin. Due to its low viscosity, aspiration of liquid may result in diffuse chemical pneumonitis, pulmonary edema, and hemorrhage. Contamination of aliphatic hydrocarbons by benzene significantly increases the hazard. Therefore it is important that benzene content, if suspected, be determined (A-5).

#### Reference

- (1) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to Alkanes*, NIOSH Doc. No. 77-151, Washington, DC (1977).

**Harmful Effects and Symptoms:** Workers who failed to use good safety practices (i.e., to cover skin and use respiratory protection) have died from endosulfan exposure. In one incident, three persons exposed showed central nervous system symptoms; two of them died. It therefore appears that the most toxic potential effect to man is that of central nervous system toxicity since the available data indicate a lack of carcinogenic, mutagenic, or teratogenic potential. The absence of reports on toxic effects associated with the proper use of endosulfan (particularly such effects as skin sensitization or other human symptoms) has been noted.

**Points of Attack:** Central nervous system, lungs, skin.

**Medical Surveillance:** Consider the points of attack in preplacement and periodic physical examinations.

**Disposal Method Suggested:** A recommended method for disposal is burial 18 inches deep in noncropland away from water supplies, but bags can be burned (A-32).

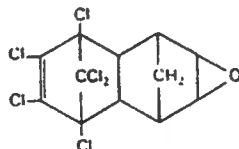
#### References

- (1) U.S. Environmental Protection Agency, *Endosulfan: Ambient Water Quality Criteria*, Washington, DC (1980).
- (2) U.S. Environmental Protection Agency, *Endosulfan, Health and Environmental Effects Profile No. 98*, Washington, DC, Office of Solid Waste (April 30, 1980).
- (3) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. II, pp VII/479-82, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

## ENDRIN

- Hazardous substance (EPA)
- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)

**Description:** Endrin is the common name of one member of the cyclodiene group of pesticides. It is a cyclic hydrocarbon having a chlorine-substituted methano bridge structure as follows:



It is a white, crystalline solid melting at 226° to 230°C.

**Code Numbers:** CAS 72-20-8 RTECS IO1575000 UN (NA 2761)

**DOT Designation:** Poison B

**Synonyms:** 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8a-octahydro-1,4-endo-endo-5,8-dimethano-naphthalene, nendrin (in South Africa), ENT 17251.

**Potential Exposures:** Those involved in manufacture (A-32), formulation and field application of this pesticide.

**Incompatibilities:** Strong oxidizers, strong acids.

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mula:

odor. It melts at

A 2761)

3979, OMS-570,  
2,4,3-benzo-diox-  
Thiofor®.

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1) has set a TWA  
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saltwater aquatic  
ug/l. To protect  
d the following  
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ollowed by gas  
action (EPA  
EPA Method



and the ACGIH  
 es the possibility  
 vel is 200 mg/m<sup>3</sup>.  
 bblber, analysis by

quatic life—0.0023  
 t saltwater aquatic  
 µg/l. To protect

followed by gas  
 detection (EPA  
 EPA Method 625).

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 in poisoning were  
 f headache. Addi-  
 rgy; weakness and  
 eath. Significantly  
 g enzymes has oc-  
 n. No irreversible  
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ssued on July 27,  
 and reductions in

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 en swallowed, get  
 vomiting. Do not

to prevent any  
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 ly if wet or con-

**Disposal Method Suggested:** A disposal procedure recommended by the manufacturer consists of absorption, if necessary, and burial at least 18 inches deep, preferably in sandy soil in a flat or depressed location away from wells, livestock, children, wildlife, etc. (A-32).

#### References

- (1) U.S. Environmental Protection Agency, *Endrin: Ambient Water Quality Criteria*, Washington, DC (1980).
- (2) U.S. Environmental Protection Agency, *Reviews of the Environmental Effects of Pollutants: XIII, Endrin*, Report EPA-600/1-79-005, Cincinnati, OH (1979).
- (3) U.S. Environmental Protection Agency, *Endrin*, Health and Environmental Effects Profile No. 99, Washington, DC, Office of Solid Waste (April 30, 1980).
- (4) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 5, 55-57, New York, Van Nostrand Reinhold Co. (1981).
- (5) See Reference (A-61).
- (6) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. 1, pp VII/269-74, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

### ENFLURANE

**Description:** CHF<sub>2</sub>OCF<sub>2</sub>CHFCI, 2-chloro-1,1,2-trifluoroethyl difluoromethyl ether is a liquid boiling at 56° to 57°C.

**Code Numbers:** CAS 13838-16-9 RTECS KN6800000

**DOT Designation:** —

**Synonyms:** Ethrane®, methylflurether.

**Potential Exposures:** This compound is used as an anesthetic.

**Permissible Exposure Limits in Air:** There is no Federal standard but ACGIH as of 1983/84 has proposed a TWA of 75 ppm (575 mg/m<sup>3</sup>). There is no proposed STEL.

**Permissible Concentration in Water:** No standards set.

**Routes of Entry:** Inhalation of vapors.

**Harmful Effects and Symptoms:** Enflurane is a potent respiratory depressant and has been reported to impair cardiac performance (A-42).

#### References

- (1) Nat. Inst. for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to Waste Anesthetic Gases and Vapors*, NIOSH Doc. No. 77-140 (1977).

### EPICHLOROHYDRIN

- Carcinogen (animal positive, IARC) (3)
- Hazardous substance (EPA)
- Hazardous waste (EPA)

**Description:** CH<sub>2</sub>OCHCH<sub>2</sub>Cl, epichlorohydrin, is a colorless liquid with a chloroform-like odor. It boils at 115°C.

(1983/84) has adopted a TWA value of 5 ppm (30 mg/m<sup>3</sup>). There is no STEL value.

**Permissible Concentration in Water:** No criteria set.

**Harmful Effects and Symptoms:** Animal experiments produced leucocytosis and kidney lesions. Human subjects reported an odor threshold at 0.003 ppm, slight eye or throat irritation at 1 to 5 ppm. Some headaches and increased urinary frequency have been reported in exposed workers (A-34).

**Personal Protective Methods:** Wear rubber gloves, face shield and work clothing.

**Respirator Selection:** An all purpose cannister mask is recommended (A-38).

**Disposal Method Suggested:** Incineration.

#### References

- (1) See Reference (A-60).

### DICYCLOPENTADIENYL IRON

**Description:** (C<sub>5</sub>H<sub>5</sub>)<sub>2</sub>Fe is an orange crystalline solid with a camphor-like odor which melts at 173° to 174°C.

**Code Numbers:** CAS 102-54-5 RTECS LK0700000

**DOT Designation:** —

**Synonyms:** Ferrocene, bis(cyclopentadienyl) iron, iron dicyclopentadienyl.

**Potential Exposures:** It is used as an additive for furnace oils and jet fuels to reduce combustion smoke. It has been proposed as an antiknock additive in gasoline. It is used as a curing agent for rubber and silicone resins. It has been proposed as a high temperature lubricant and as a raw material for high temperature polymers.

**Permissible Exposure Limits in Air:** There is no Federal standard but ACGIH (1983/84) has adopted a TWA value of 10 mg/m<sup>3</sup> and set a tentative STEL of 20 mg/m<sup>3</sup>.

**Permissible Concentration in Water:** No criteria set, but EPA (A-37) has suggested a permissible ambient goal of 530 µg/l based on health effects.

**Harmful Effects and Symptoms:** Ferrocene is classified as a slightly toxic material, but the toxicological properties have not been extensively investigated (A-34).

#### References

- (1) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 4, 67-68, New York, Van Nostrand Reinhold Co. (1981).

### DIELDRIN

- Carcinogen (Animal positive, IARC) (3) (EPA-CAG) (A-40)
- Hazardous substance (EPA)
- Hazardous waste (EPA)

- Priority toxic pollutant

**Description:** C<sub>12</sub>H<sub>8</sub>Cl<sub>4</sub>O<sub>4</sub>

a colorless to light tan solid

**Code Numbers:** CAS 60-

**DOT Designation:** ORM-

**Synonyms:** 1,2,3,4,10,11,1,4-endo-exo-5,8-dimethano

**Potential Exposure:** Ald to the group of cyclodiene cyclic hydrocarbon insectic factured in the United Stat ited their manufacture in Rodenticide Act. They w Holland. Prior to 1974, bot various formulations for brc

The primary use of the although they were also us where there is no effluent d

Dieldrin's persistence in ity (i.e., a vapor pressure o ity in water (186 µg/l at 2 resulting in a high affinity f plant waxes, and other suc ity of dieldrin results in th may result in a concentratio for a consumer.

Waters sampled in the U up to 0.05 µg/l. The stand contain about 43 ng/g of dii fat, meat and meat by-pro and 0.1 ppm respectively.

Children, especially inf shown to contain dieldrin. tains dieldrin residues and t tions of dieldrin from that s

**Incompatibilities:** Strong phenols.

**Permissible Exposure Li** ACGIH TWA value is 0.25 of cutaneous absorption. TI mg/m<sup>3</sup>.

6-2-

**Determination in Air:** Collection on a filter, workup in isooctane, analysis by gas chromatography. See NIOSH Methods, Set T. See also reference (A-10).

**Permissible Concentration in Water:** To protect freshwater aquatic life—0.0019  $\mu\text{g}/\ell$  as a 24 hr average, never to exceed 2.5  $\mu\text{g}/\ell$ . To protect saltwater aquatic life—0.0019  $\mu\text{g}/\ell$  as a 24 hr average never to exceed 0.71  $\mu\text{g}/\ell$ . To protect human health—preferably zero. An additional lifetime cancer risk of 1 in 100,000 results at a level of 0.71  $\text{ng}/\ell$  (0.00071  $\mu\text{g}/\ell$ ).

**Determination in Water:** Methylene chloride extraction followed by gas chromatography with electron capture or halogen specific detection (EPA Method 608) or gas chromatography plus mass spectrometry (EPA Method 625).

**Routes of Entry:** Inhalation, skin absorption, ingestion, eye and skin contact.

**Harmful Effects and Symptoms:** During the past decade, considerable information has been generated concerning the toxicity and potential carcinogenicity of the two organochlorine pesticides, aldrin and dieldrin. These two pesticides are usually considered together since aldrin is readily epoxidized to dieldrin in the environment. Both are acutely toxic to most forms of life including arthropods, mollusks, invertebrates, amphibians, reptiles, fish, birds and mammals. Dieldrin is extremely persistent in the environment. By means of bioaccumulation it is concentrated many times as it moves up the food chain.

Symptoms of dieldrin exposure include: headaches, dizziness, nausea, vomiting, malaise and sweating; myoclonic limbjerks; clonic or tonic convulsions; coma.

**Points of Attack:** Central nervous system, liver, kidneys, skin.

**Medical Surveillance:** Consider the points of attack in preplacement and periodic physical examinations.

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, wash with soap immediately. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** Wear appropriate clothing to prevent any possibility of skin contact. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately when skin is wet or contaminated. Work clothing should be changed daily if it is possible that clothing is contaminated. Remove nonimpervious clothing immediately if wet or contaminated. Provide emergency showers and eyewash.

#### Respirator Selection:

- 2.5  $\text{mg}/\text{m}^3$ : CCROVDM Pest/SA/SCBA
- 12.5  $\text{mg}/\text{m}^3$ : CCROVDM Pest/GMOVDM Pest/SAF/SCBAF
- 250  $\text{mg}/\text{m}^3$ : PAPOVHiEPest/SA:PD,PP,CF
- 450  $\text{mg}/\text{m}^3$ : SAF:PD,PP,CF
- Escape: GMOVPPest/SCBA

**Disposal Method Suggested:** Incineration (1500°F, 0.5 second minimum for primary combustion; 3200°F, 1.0 second for secondary combustion) with adequate scrubbing and ash disposal facilities (A-31).

#### References

- (1) U.S. Environmental Protection Agency, *Aldrin/Dieldrin: Ambient Water Quality Criteria*, Washington, DC (1980).



$(C_6H_{11})_2NH$ , mw: 181.32, mp:  $-1^\circ$ , bp:  $256^\circ$ , flash p:  $> 210^\circ F$  (OC), d: 0.910, vap. d: 6.27.  
Acute tox data: Oral  $LD_{50}$  (rat) = 373 mg/kg; sc  $LD_{50}$  (mouse) = 135 mg/kg. [3]

THR = HIGH via oral and sc route. An exper neo. [3]

Animal exper show intense local irr and nervous excitation. See also cyclohexylamine.

Fire Hazard: Low, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Alcohol foam,  $CO_2$ , dry chemical.

**DICYCLOHEXYLAMINE NITRITE.**  $C_{12}H_{23}N \cdot NO_2H$ , mw: 228.4.

Acute tox data: Oral  $LD_{50}$  (rat) = 284 mg/kg; oral  $LD_{50}$  (mouse) = 205 mg/kg. [3]

THR = HIGH via oral route. An exper neo. [3]

Fire Hazard: Dangerous; see nitrates.

Disaster Hazard: Dangerous; see nitrates.

**DICYCLOHEXYL PHTHALATE.** White solid.

$C_6H_4(COOC_6H_{11})_2$ , mw: 330.5, mp:  $58^\circ$ , bp:  $200^\circ - 235^\circ$  @ 4 mm, flash p:  $405^\circ F$ , d: 1.148 @  $20^\circ/20^\circ$ , vap. press: 0.1 mm @  $150^\circ$ .

THR = Probably MOD to LOW.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Water, foam,  $CO_2$ , dry chemical.

**DICYCLOPENTADIENE.** Colorless crystals.  $C_{10}H_{12}$ , mw: 132.3, mp:  $32.9^\circ$ , bp:  $166.6^\circ$ , d: 0.976 @  $35^\circ$ , vap. press: 10 mm @  $47.6^\circ$ , vap. d: 4.55, flash p:  $90^\circ F$  (OC).

Acute tox data: Oral  $LD_{50}$  (rat) = 353 mg/kg; inhal  $LC_{Lo}$  (rat) = 500 ppm for 4 hrs; dermal  $LD_{50}$  (rabbit) = 5080 mg/kg. [3]

THR = HIGH via oral and inhal; MOD via dermal routes.

Fire Hazard: Dangerous, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Alcohol foam.

**DICYCLOPENTADIENYL IRON.** See ferrocene.

**DICYCLOPENTENYL ALCOHOL.** Liquid.  $C_{10}H_{17}O$ , mw: 153.2, bp:  $238^\circ$ , flash p:  $426^\circ F$ , d: 1.07, vap. d: 5.3.

THR = U. See also alcohols.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Water, foam,  $CO_2$ , dry chemical.

**DI-(DECANOYL)TRIETHYLENE GLYCOL ESTER.**

$C_{26}H_{50}O_6$ , mw: 458.8.

Acute tox data: Oral  $LD_{50}$  (rat) = 7460 mg/kg; dermal  $LD_{50}$  (rabbit) = 11,000 mg/kg. [3]

THR = LOW via oral and dermal route.

**DIDECYL ADIPATE.** A clear liquid.

$(C_{10}H_{21}CO_2)_2C_4H_8$ , mw: 426, bp:  $240^\circ$  @ 4 mm,

fp:  $-72^\circ$ , flash p:  $425^\circ F$  (COC), d: 0.916–0.922 @  $20^\circ/20^\circ$ .

THR = U. Limited animal exper suggest LOW toxicity. See also esters and adipic acid.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam,  $CO_2$ , dry chemical.

**DI-n-DECYLAMINE.** Liquid.  $(C_{10}H_{21})_2NH$ , mw: 297.5, bp:  $195^\circ$  @ 12 mm, vap. d: 10.3.

THR = U. See also amines.

Fire Hazard: Mod, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Water spray, mist, foam, dry chemical.

**DIDECYL ETHER.**  $C_{20}H_{42}O$ , mw: 298.4, autoign. temp.:  $419^\circ F$ , vap. d: 10.3.

THR = No data. See also ethers.

Fire Hazard: Low. See ethers.

To Fight Fire: Alcohol foam, water, mist or spray.

**DIDECYL PHTHALATE.** A clear liquid.

$(C_{10}H_{21}CO_2)_2C_6H_4$ , mw: 446, bp:  $252^\circ$  @ 4 mm, fp:  $-53^\circ$ , flash p:  $450^\circ F$  (COC), d: 0.964–0.968 @  $20^\circ/20^\circ$ .

Acute tox data: Dermal  $LD_{50}$  (rabbit) = 17,000 mg/kg. [3]

THR = Virtually non-toxic via dermal route. See also esters and phthalic acid.

Fire Hazard: Slight, when exposed to heat or flame; can react with oxidizing materials.

To Fight Fire: Foam,  $CO_2$ , dry chemical.

**3,8-DIDEHYDRO RETRONECINE.**  $C_8H_{11}O_2N$ , mw: 153.2.

THR = An exper neo to rats via sc route. [103]

**DIDIPHENYLAMINE FLUOSILICATE.** White crystals.  $[(C_6H_5)_2NH]_2 \cdot H_2SiF_6$ , mw: 482.5, mp:  $169^\circ$ .

THR = HIGH. See fluosilicates.

Disaster Hazard: Dangerous; see fluosilicates.

**DIDODECYLAMINE.** White solid, slight ammoniacal odor.  $(C_{12}H_{25})_2NH$ , mw: 253.7, mp:  $50^\circ$ , bp:  $210^\circ$  @ 1 mm.

THR = U. See also amines.

**DIDYMIUM NITRATE.** Violet-red, hygroscopic crystals.

Comp: a mixture of praseodymium and neodymium nitrates.

THR = See nitrates.

Radiation Hazard: Didymium salts are usually slightly radioactive from the presence of thorium as an impurity.

Fire Hazard: See nitrates.

Disaster Hazard: See nitrates.

**DIELDRIN.** Syns: 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-di-

## 718 HEXACHLORODISILANE

like skin rashes. See also chlorinated phenols and aldrin.

Disaster Hazard: Dangerous, see chlorides.

**HEXACHLORODISILANE.** See disilicon hexachloride.

**1,2,3,4,10,10-HEXACHLORO-6,7-EPOXY-1,4,4a,5,6,7,8,8a-OCTAHYDRO-1,4,5,8-ENDO-ENDO-DIMETHANONAPHTHALENE.** See endrin.

**1,2,3,4,10,10-HEXACHLORO-6,7-EPOXY-1,4,4a,5,6,7,8,8a-OCTAHYDRO-1,4,5,8-ENDO-EXO-DIMETHANONAPHTHALENE.** See dieldrin.

**HEXACHLOROETHANE.** Syn: *carbon trichloride*, *carbon hexachloride*. Rhombic triclinic or cubic crystals, colorless, camphor-like odor.  $\text{CCl}_3\text{CCl}_3$ , mw: 236.76, mp: 186.6° (sublimes), d: 2.091, vap. press: 1 mm @ 32.7°.

Acute tox data: Iv MLD (dogs) = 325 mg/kg; sc MLD (rabbit) = 4000 mg/kg. [3]

THR = HIGH via iv and MOD via sc; probably MOD to HIGH via oral and dermal routes. Liver injury has been described from exposure to this material. See also chlorinated hydrocarbons.

Explosion Hazard: Slight, by spont chemical reaction. Dehalogenation of this material by reaction with alkalis, metals, etc., will produce spont explosive chloroacetylenes.

Disaster Hazard: Dangerous; when heated to decomp, emits highly toxic fumes of phosgene.

**1,2,3,4,10,10-HEXACHLORO-1,4,4a,8,8a-HEXAHYDRO-1,4,5,8-ENDO-DIMETHANONAPHTHALENE.** Syn: *isodrin*. Crystals.

$\text{C}_{12}\text{H}_8\text{Cl}_6$ , mw: 364.9, mp: 241°.

Acute tox data: Oral  $\text{LD}_{50}$  (rat) = 7 mg/kg; dermal  $\text{LD}_{50}$  (rat) = 23 mg/kg.

THR = HIGH via oral and dermal routes. An insecticide.

**HEXACHLOROMELAMINE.**  $\text{C}_3\text{N}_6\text{Cl}_6$ , mw: 332.7. Reacts violently with acetone,  $\text{NH}_3$ , aniline, diphenylamine, organic contaminants, turpentine. [19]

**HEXACHLOROMETHYL CARBONATE.** Syn: *triphosgene*. White crystals.  $(\text{OCCl}_3)_2\text{CO}_2$ , mw: 329.8, mp: 78°–79°, bp: 205°–206° (partial decomp), d: 2 (approx).

THR = HIGH irr to skin, eyes and mu mem.

Disaster Hazard: Dangerous; when heated to decomp, emits highly toxic fumes of chlorides.

**HEXACHLOROMETHYL ETHER.** Liquid.  $\text{O}(\text{CCl}_3)_2$ , mw: 252.76, bp: 98° (partial decomp), d: 1.538 @ 18°.

THR = MOD to HIGH irr to skin, eyes and mu mem.

Disaster Hazard: Dangerous; when heated to decomp, emits highly toxic fumes of chlorides.

**HEXACHLORONAPHTHALENE.** Wh  $\text{C}_{10}\text{H}_2\text{Cl}_6$ , mw: 334.9.

Acute tox data: Oral  $\text{LD}_{10}$  (cattle) = 11 mg/kg. THR = HIGH via oral route. Probably dermal and inhal routes as well. Causes acne form eruptions and toxic narcosis. Absorbed by skin.

**HEXACHLOROPHENE.** See 2,2'-methyl (3,4,6-trichlorophenol).

**HEXACHLOROPROPENE.**  $\text{C}_3\text{Cl}_6$ , mw: 248. Acute tox data: Inhal  $\text{LC}_{50}$  (rat) = 425 ppm hour; ip  $\text{LD}_{50}$  (rat) = 40 mg/kg.

THR = HIGH via inhal and ip routes. Probably via oral route as well. A powerful irritant.

Disaster Hazard: Dangerous, see chlorides

**n-HEXADECANE.** Syn: *cetane*. Colorless liquid. Insol in water, alcohol, acetone and ether, insol in water. C<sub>16</sub>H<sub>34</sub>, mw: 226, d: 0.77335 @ 20°/4°, bp: 286.5°, mp: 18.2°, d: 7.8, autoign. temp.: 401°F, flash p: >21°F. THR = U.

Fire Hazard: Low, when exposed to heat. To Fight Fire: Water spray, mist,  $\text{CO}_2$ , dry foam.

**tert-HEXADECANETHIOL.** Syn: *tert-hexadecanethiol*. Colorless liquid, insol in water. C<sub>16</sub>H<sub>34</sub>S, mw: 258, boiling range: 121°–149° @ 0.874 mm @ 15°/15°, flash p: 265°F (OC).

THR = Details U. See mercaptans.

Fire Hazard: Slight, when exposed to heat. Disaster Hazard: Dangerous; when heated to decomp, emits highly toxic fumes.

To Fight Fire: Dry chemical,  $\text{CO}_2$ .

**HEXADECANOL.** See cetyl alcohol.

**1-HEXADECENE.** Syn: *1-hexadecyne*. Liquid.  $\text{CH}_3(\text{CH}_2)_{13}\text{C}\equiv\text{CH}$ , mw: 222.40, mp: 274.0°, d: 0.797 @ 20°, vap. press: 1 mm @ 274.0°, d: 7.68, flash p: >212°F, autoign. temp.: 401°F. THR = U.

Fire Hazard: Low, when exposed to heat. Can react with oxidizing materials.

To Fight Fire: Foam,  $\text{CO}_2$ , dry chemical.

**HEXADECYL ACETYLENE.** See 1-octadecyne

**tert-HEXADECYL MERCAPTAN.** See *tert-hexadecanethiol*.

**HEXADECYL TETRATHIO-o-STANNATE.**  $\text{Sn}(\text{SC}_6\text{H}_{13})_4$ , mw: 1148.7, mp: 54°.

THR = See tin and sulfur compounds.

**HEXADECYL TRICHLOROSILANE.** Colorless liquid.  $\text{C}_{16}\text{H}_{33}\text{SiCl}_3$ , mw: 259.5, d: 1.25°/25°, bp: 269°, flash p: 295°F (COC).

THR = MOD irr to skin, eyes and mu mem.

stored in an exper animal than is sufficient as a lethal dose for that same animal if given at one time. A study based on 75 human cases reported an average of 5.3 ppm of DDT stored in the fat. A higher content of DDT and its derivatives (up to 434 ppm of DDE and 648 ppm of DDT) was found in workers who had very extensive exposure. Without exception, the samples were taken from persons who were either asymptomatic or suffering from some disease completely unrelated to DDT. Careful hospital examination of workers, who had been very extensively exposed and who had volunteered for examination revealed no abnormality which could be attributed to DDT. Much higher levels than have been found in man have been observed in the fat of exper animals which were apparently asymptomatic. DDT stored in the fat is eliminated only very gradually when further dosage is discontinued. After a single dose, the secretion of DDT in the milk and its excretion in the urine reach their height within a day or two and continue at a lower level thereafter.

**Dangerous Acute Dose in Man:** A dose of 20 g has proved highly dangerous though not fatal to man. This dose was taken by 5 persons who vomited an unknown portion of the material and even so recovered only incompletely after 5 weeks. Smaller doses produced less important symptoms with relatively rapid recovery. Exper ingestion of 1.5 g resulted in great discomfort and moderate neurological changes including paraesthesia, tremor, moderate ataxia, exaggeration of part of the reflexes, headache, and fatigue. Vomiting followed only after 11 hours. Recovery was complete on the following day. The fatal dose of DDT for man is not known. Judging from the literature, no one has ever been killed by DDT in the absence of other insecticides and/or a variety of toxic solvents. However, these common solvent formulations are highly fatal when taken in small doses, partly because of the toxicity of the solvent, and perhaps because of the increased absorbability of the DDT; several fatal cases in man have been reported. Acute oral toxicity for man = 250 mg/kg. Acute oral LD<sub>50</sub> (rat) = 113 mg/kg (tech grade). Federal fruit and vegetable tolerance = 7 ppm.

**Dangerous Chronic Dose in Man:** Even less is known of the hazard of chronic DDT poisoning. It is known that certain exper animals fed diets containing one part of DDT per million store the compound in their fat. The storage of DDT in man has been mentioned above. The exact significance of these findings is not known and their further investigation is of the greatest importance. Human

volunteers have ingested up to 35 mg/day for 21 months with no ill effects.

**Signs and Symptoms of Poisoning in Man:** In patients who ate substantial doses of DDT in flour, the symptoms observed were vomiting, numbness and partial paralysis of the extremities, mild convulsions, loss of proprioception and vibratory sensation of the extremities, and hyperactive knee jerk reflexes. Symptoms appeared in 30 to 60 min after eating the DDT. The paralysis and numbness were most evident in the most distal portions of the extremities, and their intensity was directly proportional to the amount of DDT ingested. All the patients were apprehensive and excited; respiration was moderately rapid; pulse remained slow to normal. The immediate protective mechanism in man, following substantial doses, is vomiting. With smaller doses, nausea and vomiting are less prominent, but diarrhea has been observed. Signs and symptoms of chronic poisoning in man are unknown, although, judging from the observed microscopic changes in exper animals, liver and kidney dysfunctions should be looked for. The primary irr of DDT is practically nil, and it has little or no tendency to produce allergy. Dermatitis induced by DDT has occasionally been reported, but these reports are unconfirmed; nevertheless the phenomenon should be expected to occur in rare instances.

**Laboratory Findings:** Laboratory findings are essentially negative except for the presence of DDT which may be quantitatively measured in stomach contents, urine, or tissues.

**Treatment of Poisoning:** Depending on the condition of the patient, attention should first be given to the sedation or to the removal of poison which may have been taken internally. Stomach lavage and saline laxatives may be used. Oil laxatives should be avoided; they promote absorption of DDT and of many organic solvents. The five drugs of choice, arranged roughly in order of their effectiveness, are phenobarbital, pentobarbital, paraldehyde, urethane, and calcium gluconate. Phenobarbital, which has been used in doses up to 0.7 g per day in epilepsy, and pentobarbital (0.25 to 0.5 g) are the barbiturates known to control convulsions of central origin. Paraldehyde (average dosage 15 cc orally, 1 cc undiluted intravenously, 35 cc rectally in normal saline) controls the convulsions of DDT-poisoned animals. Urethane (human dosage 1 to 4 g) has proved very effective in rats, but it should be remembered that the hypnotic and narcotic effects of urethane are not correspondingly high in man. Urethane has an added advantage, however,

chemical contacts the skin, wash with soap promptly. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** Wear appropriate clothing to prevent repeated or prolonged skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Work clothing should be changed daily if clothing is contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

**Respirator Selection:**

100 mg/m<sup>3</sup>: CCROVDPest/SA/SCBA

500 mg/m<sup>3</sup>: CCROVDPest/DMOVDMPest/SAF/SA:PD,PP,CF/SCBAF

Escape: GMOVPPest/SCBA

**Disposal Method Suggested:** Incineration of phenoxys is effective in one second at 1800°F using a straight combustion process or at 900°F using catalytic combustion. Over 99% decomposition was reported when small amounts of 2,4-D were burned in a polyethylene bag (A-32).

**References**

- (1) U.S. Environmental Protection Agency, *2,4-Dichlorophenoxy Acetic Acid*, Health and Environmental Effects Profile No. 77, Washington, DC, Office of Solid Waste (April 30, 1980).
- (2) See Reference (A-61).
- (3) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. 1, pp VII/8-11, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

**DDT**

- Carcinogen (Animal suspected, IARC) (4) (Potential, EPA) (A-40). (Negative, NCI) (5)
- Hazardous substance (EPA)
- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)

**Description:** CCl3

ClC6H4CH(C6H4Cl)C6H5 is a waxy solid of indefinite melting point with a weak, chemical odor.

**Code Numbers:** CAS 50-29-3 RTECS KJ3325000 UN (NA 2761)

**DOT Designation:** ORM-A

**Synonyms:** p,p'-DDT, 2,2-bis(p-chlorophenyl)-1,1,1-trichloroethane, dichlorodiphenyltrichloroethane, ENT 1506, dicophane, chlorophenothane, Gesarol®, Guesarol® and Neocid®.

**Potential Exposure:** DDT is a low-cost broad-spectrum insecticide. However, following an extensive review of health and environmental hazards of the use of DDT, U.S. EPA decided to ban further use of DDT in December 1972. This decision was based on several properties of DDT that had been well evidenced: (1) DDT and its metabolites are toxicants with long-term persistence in soil

**First Aid:** If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, wash with soap promptly. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

**Personal Protective Methods:** Wear appropriate clothing to prevent repeated or prolonged skin contact. Wear eye protection to prevent any reasonable probability of eye contact. Employees should wash promptly when skin is wet or contaminated. Work clothing should be changed daily if it is possible that clothing is contaminated. Remove nonimpervious clothing promptly if wet or contaminated.

#### Respirator Selection:

- 10 mg/m<sup>3</sup>: CCROVDM<sub>Pest</sub>/SA/SCBA
- 50 mg/m<sup>3</sup>: CCROVDM<sub>Pest</sub>/GMOVDM<sub>Pest</sub>/SAF/SCBAF
- 500 mg/m<sup>3</sup>: CCROVHiE<sub>Pest</sub>/SA:PD,PP,CF

**Disposal Method Suggested:** Incineration has been successfully used on a large scale for several years and huge incinerator equipment with scrubbers to catch HCl, a combustion product, are in use at several facilities such as Hooker Chemical, Dow Chemical and other producers of chlorinated hydrocarbon products. One incinerator operates at 900° to 1400°C with air and steam added which precludes formation of Cl<sub>2</sub>. A few companies also construct incinerator-scrubber combinations of smaller size, e.g., a system built by Garver-Davis, Inc., of Cleveland, Ohio, for the Canadian government can handle 200 to 500 lb DDT/day as a kerosene solution (A-32).

#### References

- (1) U.S. Environmental Protection Agency, *DDT: Ambient Water Quality Criteria*, Washington, DC (1980).
- (2) U.S. Environmental Protection Agency, *DDT Health and Environmental Effects Profile No. 60*, Washington, DC, Office of Solid Waste (April 30, 1980).
- (3) U.S. Environmental Protection Agency, *DDE Health and Environmental Effects Profile No. 59*, Washington, DC, Office of Solid Waste (April 30, 1980).
- (4) International Agency for Research on Cancer, *IARC Monographs on the Carcinogenic Risks of Chemicals to Humans*, Lyon, France, 5, 83 (1974).
- (5) National Cancer Institute *Bioassay of DDT, TDE and DDE for Possible Carcinogenicity*, Technical Report Series No. 131, Bethesda, MD (1978).
- (6) World Health Organization, *DDT and Derivatives*, Environmental Health Criteria No. 9, Geneva, Switzerland (1979).
- (7) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 51-54, New York, Van Nostrand Reinhold Co. (1981).
- (8) Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety*, Third Edition, Vol. 1, pp 592-93, Geneva, International Labour Office (1983).
- (9) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. 1, pp VII/328-31, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

## DECABORANE

**Description:** B<sub>10</sub>H<sub>14</sub> is a colorless solid with a pungent odor. It melts at 100°C.

**Code Numbers:** CAS 17702-41-9 RTECS HD1400000 UN 1868

**OSHA Designation:** Flammable Solid and Poison



**2,2'-DICHLOROBENZIDINE.** Crystalline, needle-like, insol in water, sol in alcohol and ether.

$C_6H_3ClNH_2C_6H_3ClNH_2$ , mw: 253.14, mp: 165°, vap. d: 8.73.

THR = MOD irr via oral and dermal routes. An allergen.

**3,3'-DICHLOROBENZIDINE.** Crystals, insol in water, sol in alcohol, benzene and glacial acetic acid.  $C_{12}H_{10}Cl_2N_2$ , mw: 253.1, mp: 133°.

Acute tox data: Oral LD<sub>50</sub> (rat) = 4740 mg/kg. [3]

THR = See 2,2'-dichlorobenzidine. An exper carc. [3, 10, 23]

Disaster Hazard: See 2,2'-dichlorobenzidine and benzidine.

**4,4'-DICHLOROBENZILIC ACID ETHYL ESTER.** See ethyl-4,4'-dichlorobenzilate.

**2,6-DICHLOROBENZONITRILE.** Syn: *dichlobenil*.

White solid, almost insol in water, sol in organic solvents.  $(Cl)_2C_6H_3CN$ , mw: 172, mp: 144°.

Acute tox data: Oral LD<sub>50</sub> (rat) = 2710 mg/kg; dermal LD<sub>50</sub> (rabbit) = 1350 mg/kg. [3]

THR = MOD via oral and dermal routes. Does not hydrolyze to HCN in body. Less toxic than most aliphatic nitriles. See also benzonitrile.

Disaster Hazard: Dangerous; see chlorides and nitriles.

**2,4-DICHLOROBENZOYL PEROXIDE PASTE WITH DIBUTYL PHTHALATE.** Syn: *luperco* CCC. Thick white paste insol in water, sol in organic nonpolar solvents.  $(Cl_2C_6H_3CO)_2O_2$  + dibutyl phthalate.

THR = See peroxides, organic.

**3,4-DICHLOROBENZYL ALCOHOL.** Crystals.

$Cl_2C_6H_3CH_2OH$ , mw: 177.1, vap. d: 6.1.

Acute tox data: Oral LD<sub>50</sub> (rat) = 810 mg/kg; dermal LD<sub>50</sub> (rabbit) = 400 mg/kg. [3]

THR = MOD via oral; HIGH via dermal routes. An insecticide. See also alcohols.

Disaster Hazard: Dangerous; see chlorides.

**2,4-DICHLOROBENZYL CHLORIDE.** Liquid.

$Cl_2C_6H_3CH_2Cl$ , mw: 195.5, vap. d: 6.76.

THR = U. An insecticide. See also *p*-dichlorobenzene.

Disaster Hazard: Dangerous; see chlorides.

**3,4-DICHLOROBENZYL CHLORIDE.** Liquid.

$Cl_2C_6H_3CH_2Cl$ , mw: 195.5, bp: 255°, vap. d: 6.76.

THR = U. An insecticide. See also chlorobenzene.

Disaster Hazard: Dangerous; see chlorides.

**1,1-DICHLORO-2,2-BIS-(*p*-CHLOROPHENYL) ETHYLENE.** Syn: *DDD*.  $C_{14}H_8Cl_4$ , mw: 318.

THR = An exper neo. [3]

**1,1-DICHLORO-2,2-BIS-(*p*-ETHYLPHENYL) ETHANE.** See perthane.

**O-(2,5-DICHLORO-4-BROMOPHENYL)-*o*-**

**METHYL PHENYL THIOPHOSPHONATE.** Syn: *phosvel*. Slightly sol in water, very sol acetone.

$C_{13}H_{10}O_2PSBrCl_2$ , mw: 412.1, mp: 70.4°, d: 1.53 @ 25°.

Acute tox data: Oral LD<sub>50</sub> (rat) = 42 mg/kg; oral LD<sub>50</sub> (rabbit) = 124 mg/kg; dermal LD<sub>50</sub> (rabbit) = 800 mg/kg. [3]

THR = HIGH via oral and dermal routes. On humans the effects include partial paralysis, failure in muscular coordination, suffocation, hardening of the arteries, encephalitis, delayed neuropathy, myelin degeneration. [21, 3]

**1,1-DICHLOROBUTANE.**  $Cl_2CHCH_2CH_2CH_3$ , mw: 127.0, autoign. temp.: 527°F, vap. d: 4.38.

THR = U. Animal experiments suggest moderate toxicity. See also chlorinated hydrocarbons, aliphatic.

Fire Hazard: Mod, via heat, ignition sources, oxidizers.

To Fight Fire: Alcohol foam, dry chemical, fog, mist, water spray.

**1,4-DICHLOROBUTANE.** Syn: *sym-dichlorobutane*.

Colorless, mobile liquid with mild, pleasant odor.  $CH_2ClCH_2CH_2CH_2Cl$ , mw: 127.02, bp: 155°, flash p: 126°F (TOC), d: 1.141, vap. d: 4.4, vap. press: 4 mm @ 20°.

THR = U. See 1,1-dichlorobutane.

Fire Hazard: Mod, when exposed to heat or flame or oxidizers.

Disaster Hazard: Dangerous; see chlorides; can react vigorously with oxidizing materials.

To Fight Fire: Foam, CO<sub>2</sub>, dry chemical, water.

**2,3-DICHLOROBUTANE.** Liquid.

$C_4H_7Cl_2$ , mw: 127, mp: -80°, bp: 116.0°, flash p: 194°F (OC), vap. press: 40 mm @ 35.0°, vap. d: 4.4, d: 1.1.

THR = U. See also chlorinated hydrocarbons, aliphatic and 1,1-dichlorobutane.

Fire Hazard: Mod, when exposed to heat or flame.

Explosion Hazard: U.

Disaster Hazard: Dangerous; see chlorides; can react vigorously with oxidizing materials.

To Fight Fire: Foam, CO<sub>2</sub>, dry chemical.

**sym-DICHLOROBUTANE.** See 1,4-dichlorobutane.

**1,3-DICHLORO-2-BUTENE.**  $CH_2ClCHCClCH_3$ , mw:

125.01, bp: 123°, flash p: 80°F (CC), vap. d: 4.31.

Acute tox data: Inhal LC<sub>50</sub> (rat) = 546 ppm for 4 hrs. [3]

THR = HIGH via inhal route. See also chlorinated hydrocarbons, aliphatic.

Fire Hazard: Dangerous, when exposed to heat, flame or oxidizers.

Spont Heating: No.

# **Appendix B**

## **Odor Properties**

Odor Properties of Some RNA Chemical Agents

Odor

Newly Mowed Hay

Fruity

Peach Kernel

Garlic

Geranium

Common Name

Phosgene, Diphosgene

Tabun, Soman, Nitrogen Mustard

Hydrogen Cyanide

Arsine, Distilled Mustard,  
Mustard-Timex

Lewisite



# **Appendix C**

## **Chemical Data**

CHEMICALS KNOWN TO HAVE BEEN PRESENT AT  
ROCKY MOUNTAIN ARSENAL

Acetaldehyde  
Acetaldoxime  
Acetic Acid  
Acetone  
Acetone Cyanohydrin  
Acetylene  
Acids (mixed)  
Aerosol OT-100%  
AXTON\* Insecticide      Phosphorothioic acid, O- 2,5-(dischlorophenyl) vinyl 0,0-diethyl ester  
Aldrin      Hexachlorohexahydro-endo, exo-dimethanonaphthalene (principal constituent, known as HHDN)  
ALDRITE\* Insecticide  
Alizarian Cyanone green dye  
Allyl Chloride  
Aluminum  
Aluminum Chloride  
Aluminum Compounds  
Aluminum Hydroxide  
Aluminum Oxide  
-Amino-iso-butyronitrile  
Ammonia  
Ammonium Chloride  
Antimony  
Armeen DMCD  
Arsenic (including following as compounds)  
Arsenic Compounds  
Arsenic Oxide  
Arsenic Salts  
Arsenic Trichloride  
Arsenic Trioxide  
Arsenious Chloride  
Atrazine Herbicide      2-chloro-4-ethylamino-6-isopropylamino-s-triamine  
Attaclay  
AZODRIN\* Insecticide      Dimethyl phosphate of 3-hydroxy-N-methyl cis-crotonamine  
Azodrin Related Salts  
Barium  
Bentonite HPM 20  
Benzaldehyde  
Benzene  
Benzol  
Benzothiazole  
Beryllium  
Bicarbonate  
Bicycloheptadiene  
BIDRIN\* Insecticide      3-(dimethoxyphosphinyloxy)-N,N-dimethyl-cis-crotonamide  
Bis (diisopropylaminoethyl)disulfide  
Bis (diisopropylaminoethyl)sulfide  
Bismuth  
BLADEX\* Herbicide      2-(4-chloro-6-ethylamino-s-triazin-2-ylamino)-2-methylpropionitrile  
Boron

Cyclopentadiene  
 DDE  
 D-D\* Soil Fumigant  
 ODT  
 DDVP  
 Diazinon  
 DIBROM 1,2-Dibromo-2,2-Dichloroethyl Dimethylphosphate  
 1,2-Dibromo-3-Chloropropane  
 Dichloroacetyl Chloride  
 Dichlorobenzene  
 Dichloroethane  
 Dichloroethylene  
 5.7-Dichloro-2-Methyl Benzofuran  
 Dicyclohexylphthalate  
 Dicyclopentadiene  
 Dielddrin Hexachloroepoxyoctahydro-endo,exo-dimethanonaphthalene  
 (principal constituent, known as HEOD)  
 Diethyldimethyldiphosphonate  
 O,O-diethyl phosphorochloridothionate  
 Di(2-ethylhexyl)phthalate  
 Diisobutylphthalate  
 Diisopropylaminoethanethiol  
 Diisopropylaminoethanol  
 Diisopropylaminoethylmethylphosphonothioate  
 N,N-Diisopropylcarbodiimide  
 Diisopropyldimethyldiphosphonate  
 Diisopropylmethyl Phosphonate  
 Diketene  
 N,N-Dimethylacetoacetamide  
 Dimethylamine  
 Dimethyl Disulfide  
 Dimethyl Hydrazine  
 Dimethyl Methyl Phosphonate  
 Di-n-butylphthalate  
 1-Dinitrobenzene  
 Dinitrochlorothiophenol  
 Dipropyl Amine  
 di-n-propylamine  
 Dioctyladipate  
 Dioctylphthalate  
 Dipotassium acid phosphate  
 Dithiane  
 Dursban  
 Erulphogene BC-720  
 Endrin Hexachloroepoxyoctahydro-endo, endo-dimethanonaphthalene  
 Epichlorohydrin  
 ETAC  $C_4H_{10}O_2SPCl$   
 Ethyl Alcohol  
 Ethylamine  
 EthylBenzene  
 Ethylene Glycol  
 Ethylene Glycol Monoethyl Ether  
 Ethylmethyl-phosphonate  
 O-Ethylmethylphosphonothioate

Lead Azide  
 Lead Compounds  
 Lewisite (Arsenic)  
 Lewisite Oxide  
 Lime, Chlorinated  
 Lime, Type C  
 Lindane  
 Lithium  
 MAA  $C_3H_7ON$   
 Magnesium  
 Magnesium Compounds  
 Magnesium Metal (Coarse, Dust, Powder)  
 Magnesium Salts  
 Malathion  
 Manganese  
 Manganese Compounds  
 Marasperse B-22  
 MSCAA  $C_8H_6OCl_3N$   
 MCAA  $C_3H_6OCl N$   
 MDCAA  $C_3H_5OCl_2N$   
 Mercuric Chloride  
 Mercury  
 Mercury Compounds  
 Methoxychlor  
 N-Methylacetoacetamide  
 Methylacetoacetate  
 Methylamine  
 Methyl alcohol  
 2-methylbenzyl acetoacetate  
 methylbenzyl alcohol  
 a-methylbenzyl chloroacetoacetate  
 Methyl Chloride  
 1-methyl-2-chloroacetoacetamide  
 Methyl-2-chloroacetoacetate  
 1-methyl-2,2-dichloroacetoacetamide  
 Methylene Blue Active Substances  
 Methylene Chloride  
 Methylene Isobutyl Ketone  
 Methyl Isobutyl Ketone  
 Methyl Isocyanate  
 Methyl Mercaptan  
 Methyl Parathion 0,0-dimethyl-0-nitrophenyl thiophosphate  
 Methyl Parathion Related Salts  
 Methyl Phosphonic Acid  
 Methylphosphonicdichloride  
 Methylphosphonicdiflouride  
 Methylthioacetaldoxime  
 Methoxychlor  
 Mineral Spirits  
 Molybdenum  
 MONOCROTAPHOS 53  
 Mustard (H, HS, HD)  
 Naphthalene  
 NEMAGON\* Soil Fumigant



# Chemical Characterization of Basin F Liquid (1977)

Compound or Parameter	Units Of Measure	Concentration Range*
pH	—	6.9 - 7.2
Aldrin	µg/l	50 - 400 ppb
Isodrin	µg/l	2 - 15 ppb
Dieldrin	µg/l	5 - 110 ppb
Endrin	µg/l	5 - 40 ppb
Dithiane	µg/l	30 - 100 ppb
DIMP	µg/l	10 - 20 ppm
DMMP	mg/l	500 - 2,000 ppm
Sulfoxide	mg/l	4 - 10 ppm
Sulfone	mg/l	25 - 60 ppm
Chloride	mg/l	48,000 - 56,000 ppm
Sulfate	mg/l	21,000 - 25,000 ppm
Copper	mg/l	700 - 750 ppm
Iron	mg/l	5 - 6 ppm
Nitrogen	mg/l	120 - 145 ppm
Phosphorus (total)	mg/l	2,050 - 2,150 ppm
Hardness	mg/l	2,100 - 2,800 ppm
Fluoride	mg/l	110 - 117 ppm
Arsenic	mg/l	1.0 - 1.3 ppm
Magnesium	mg/l	35 - 40 ppm
Mercury	µg/l	26 - 29 ppb
Cyanide	µg/l	1.45 - 1.55 ppm
COD	µg/l	24,500 - 26,000 ppm
TOC	µg/l	20,500 - 22,500 ppm

\* Based on the analysis of various samples from different locations and depths in the Basin.

Source: RIC#82350R01

<u>MATERIAL</u>	<u>SPILL NUMBER</u>	<u>DATE</u>	<u>QUAN. GALLONS</u>	<u>LOCATION</u>	<u>COMMENTS</u>
Acetic acid	12	1952-70	b/	N Bldg. 516	Leaking Sewer Line
Acetic acid	24	9/79	500	Bldg. 514 Link Farm	
Aldrin	1	ca 1952	1,500	NW Bldg. 422	Removed solidified aldrin
	2	ca 1952	16,000	W Bldg. 413	"
	6	2/51	10,000	E Bldg. 422	"
	8	1950-74	b/	Ditch to Sand Creek lateral	Water seepage to ditch
	12				Leaking Sewer Line
ALDRIN Insecticide	8	1969-74	b/	Ditch to Sand Creek lateral	Water seepage to ditch
Allyl chloride	59	2/15/72	100	S Bldg. 471	
	16	6/76	550	S Bldg. 471	
	61	1/13/75	2,138	N Bldg. 471	Trapped in ditch and some recovered
AZODRIN Insecticide	5	1966	1,000	NW corner Bldg. 514	
	40	1963-81	b/	N Bldg. 514	Periodic washing of drum facilities
	54	1974	55	Bldg. 514	
				SE Bldg. 451	Dirt removed.

b/ Greater than 55 gallons; total quantity impractical to estimate.

c/ Date leak started is unknown.



<u>MATERIAL</u>	<u>SPEL</u> <u>NUMBER</u>	<u>DATE</u>	<u>QUANTITY</u> <u>GALLONS</u>	<u>LOCATION</u>	<u>COMMENTS</u>
Compound 773	15 154				
Cyclopentadiene (CPD)	28	1949-74	500	N Bldg. 521	
CPD bottoms	64	12/58	650	E Bldg. 525	
CPD dimer (NCPD)	9 28 37	1973 1953	55 200	S Bldg. 433 Trenches, Section 36	
	42 65	1949-74 9/63	b/ 1,700	S Bldg. 528 N Bldg. 514	
UCPD bottoms	20 56	1967 8/8/76	1,500 1,548	1-464A S Tank Farm	Mixed with No. 6 Fuel Oil " " " " "
D-11 Soil Fumigant	36 50	ca 1971 1975	100 250	SE Bldg. 433 S Bldg. 433	Dirt removed from ditch See Acetic Acid
Dieldrin	12				
Dinitrochlorobenzene (50 11829)	46	1/7/75	400	Around Bldg. 534	
Endrin	12				See Acetic Acid
Fuel Oil (No. 6)	20 56 60				See BPCB bottoms " " See BCB bottoms
Heptane	30	1949	2,000	N Bldg. 534	

b/Greater than 55 gallons; total quantity impractical to estimate.  
c/Date leak started is unknown.

FORM

<u>MATERIAL</u>	<u>SPILL NUMBER</u>	<u>DATE</u>	<u>QUANTITY GALLONS</u>	<u>LOCATION</u>	<u>COMMENTS</u>
Spent acid	34	1973	100	SW of E Gas holder	
	35	1973	100	N Bldg. 422	
	52	1967-75	67	T-464A	
Sulfuryl chloride	45	1958	200	Bldg. 528	
	49	1978	100	Near Flare- North Plant area.	
Trimethyl phosphite (TMP)	44	1970	3,000	N Bldg. 514	Removed dirt to depth of 2-3 ft
Toluene	4	1955	1,000	N Bldg. 514	
VAPONA Insecticide (Dichlorvos)	23	1960-80	200	S Bldg. 471	
Xylene	8				See Aldrin
	12				See Acetic Acid

b/Greater than 55 gallons; total quantity impractical to estimate.

c/Date leak started is unknown.

# **Appendix D**

## **Chemical Agent Response Guidelines**

## 1.0 INTRODUCTION

Field investigation activities at Rocky Mountain Arsenal (RMA) will be conducted in areas where historical records indicate disposal of chemical agents may have occurred. The compounds, developed by the military for defending against the enemy during warfare, include nerve, blistering, and choking agents. Onsite contractor personnel performing varied drilling, development, and sampling activities have a limited potential for exposure to low levels of agents through contact with contaminated soils, liquids, or inhalation of vapors. In addition, there is an extremely low probability that well drilling and soil sampling activities may reveal unexploded ordnance (UXO). Such devices could contain explosives and/or chemical agents. It is of uppermost concern that when these materials are suspected and/or detected proper response procedures are quickly and efficiently carried out by all personnel involved. The following sections discuss chemical agents and the response procedures of field teams and RMA personnel when agents are suspected and/or detected. Figure 1-1 summarizes emergency response actions as detailed in this report.

## 2.0 AGENTS

There are three general classes of agent known to have been stored at RMA. These are nerve agents, including GB and VX; choking agents such as phosgene; and blistering agents such as the mustard gases and Lewisite.

Agent GB is an organophosphorus compound similar to, but more toxic than, some of the insecticides in wide use today. It inhibits one of the important enzymes in the body, acetylcholinesterase (ChE). ChE is necessary for the destruction of acetylcholine. Acetylcholine, the key compound connected with transmission of nerve impulses, is usually broken down by ChE in a fraction of a second after transmission of the nerve impulse. If acetylcholine is not inactivated, as in the case of poisoning with agent GB, continued stimulation and increased function and finally exhaustion and paralysis occur.

The agent can be absorbed through the skin and easily inhaled through the respiratory tract. Oral ingestion can occur although it is a less common mode of entry. Symptoms may include a runny nose, pinpointing (myosis) of pupils, dimness of vision (especially at night), tightness of the chest, difficulty in breathing, excessive sweating, drooling, nausea and vomiting, convulsions, and death. Nerve agents are quick acting when inhaled with some symptoms developing within one or two minutes after inhalation. They act more slowly when absorbed through undamaged skin. When the eyes are exposed to nerve agent vapor or aerosol, the pupils will become pinpointed; however, pinpointing of the pupils may not occur for five to ten minutes or even longer after exposure to a very low vapor concentration of the agents. When the skin is contaminated with nerve agent, the pupils of the eyes may remain normal or become only slightly reduced in size. Excessive sweating may occur at the site of skin contamination. Just as symptoms may develop after a one-time exposure to significant amounts of the agents, repeated exposure to even very low

Mustard acts first as a cell irritant eventually destroying the cells of the tissue affected. First symptoms appear within 4 to 6 hours; the higher the concentration, the quicker the symptoms appear. Injuries produced by HD heal slowly and are very susceptible to infection. The blood vessels are damaged preventing repair functions and the good medium for bacterial growth provided by the dead tissue further spreads the infection.

Nitrogen mustard (HN) is a dark liquid similar to HD but is a derivative of ammonia and causes many of the same effects. It has a faint fishy or musty odor with equal eye and skin toxicity as HD. HN however, causes cell division resulting in tissue injury and severe diarrhea with lesions in the small intestine. Effects on the respiratory system include irritation of the nose, throat and bronchi resulting in labored respiration and bronchopneumonia after approximately 24 hours.

Lewisite (L) is a mustard related agent with a faint geranium like odor. It also is a blistering-agent with a delayed action similar to distilled mustard. It is a less lethal blistering agent because of its high vapor pressure and short duration of effectiveness. It produces effects similar to HD but also acts as a systemic poison causing pulmonary edema, diarrhea, low body temperature and low blood pressure. Liquid L causes searing sensation of the eye and permanent blindness if not decontaminated in one minute. Blistering may not appear for approximately 13 hours after exposure and is much deeper than HD. It can be fatal within 10 minutes if high doses are inhaled.

# **Appendix E**

## **Forms**

## MEDICAL DATA SHEET

This brief Medical Data Sheet will be completed by all onsite personnel and will be kept in the Command Post during the conduct of site operations. It is in no way a substitute for the Medical Surveillance Program requirements. This data sheet will accompany any personnel when medical assistance is required or if transport to hospital facilities is required.

Project Rocky Mountain Arsenal

Name \_\_\_\_\_ Home Telephone \_\_\_\_\_

Address \_\_\_\_\_

Age \_\_\_\_\_ Height \_\_\_\_\_ Weight \_\_\_\_\_

In case of emergency call \_\_\_\_\_

Allergies \_\_\_\_\_

Particular Sensitivities \_\_\_\_\_

Do You Wear Contacts? \_\_\_\_\_

Provide a Checklist of Previous Illnesses  
or Exposures to Hazardous Chemicals \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

What medications are you presently using? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Do you have any particular medical restrictions? \_\_\_\_\_

Name of Personal Physician \_\_\_\_\_ Telephone \_\_\_\_\_



**Figure 6-1**  
**Contractor Report of Suspected Chemical Agent**

Date & Time \_\_\_\_\_

Site Safety Supervisor: \_\_\_\_\_

Location: \_\_\_\_\_

Describe Activities in Progress: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Personnel Present: \_\_\_\_\_  
\_\_\_\_\_

Notification to Fire Department \_\_\_\_\_ hrs. \_\_\_\_/\_\_\_\_/\_\_\_\_

**Method of Detection**

\_\_\_\_ Physiological Symptoms (describe): \_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_ Smell/Odor (describe): \_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_ M18A2 Detector Kit: color of tube band \_\_\_\_\_  
number of drops from which bottle \_\_\_\_\_  
detector ticket \_\_\_\_\_  
color response of tube or ticket \_\_\_\_\_

\_\_\_\_ M8 Alarm \_\_\_\_\_

\_\_\_\_ M8 Detector Paper (color) \_\_\_\_\_

\_\_\_\_ HNU Photoionization Analyzer Model PI-101 (\_\_\_\_ ppm) \_\_\_\_\_

\_\_\_\_ Foxboro OVA Model 128 (\_\_\_\_ ppm) \_\_\_\_\_

\_\_\_\_ Other \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Table 6-1. Telephone Notification List**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

# SITE ENTRY LOG

[illegible]

## Daily Health and Safety Briefing Summary Form

Date \_\_\_\_\_ Time Begun \_\_\_\_\_ Time Ended \_\_\_\_\_

Briefing Location \_\_\_\_\_

Team Members Attending \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Day's Objectives (Presented by: \_\_\_\_\_)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Special Health and Safety Concerns (Presented by: \_\_\_\_\_)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Team Members' Suggestions

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Changes to Health and Safety Plan

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Other Comments

\_\_\_\_\_  
\_\_\_\_\_

Form Completed by: \_\_\_\_\_

Date: \_\_\_\_\_

EMPLOYEE EXPOSURE/INJURY INCIDENT REPORT

(SUBMIT A SEPARATE REPORT FOR EACH INCIDENT  
TO THE CORPORATE HEALTH AND SAFETY DIRECTOR)

Date: \_\_\_\_\_

Employee's Name: \_\_\_\_\_

Sex: M \_\_\_\_\_ F \_\_\_\_\_ Age: \_\_\_\_\_

Region: \_\_\_\_\_ Location: \_\_\_\_\_

Project: \_\_\_\_\_

Project Job Title: \_\_\_\_\_

Incident:

Type: Possible Exposure \_\_\_\_\_ Exposure \_\_\_\_\_ Physical Injury \_\_\_\_\_ Other \_\_\_\_\_

Location: \_\_\_\_\_

Date of Incident: \_\_\_\_\_ Time of Incident: \_\_\_\_\_

Date of Reporting Incident: \_\_\_\_\_

Person to Whom Incident Was Reported: \_\_\_\_\_

Weather Condition During Incident: Temperature \_\_\_\_\_

Wind speed & direction \_\_\_\_\_ Humidity \_\_\_\_\_

Cloud Cover \_\_\_\_\_ Clear \_\_\_\_\_ Precipitation \_\_\_\_\_

Materials Potentially Encountered:

Chemical (Give chemical name or description--liquid, solid, gas, vapor, fume, mist):

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Radiological: \_\_\_\_\_

Others: \_\_\_\_\_

List the names of other persons affected during this incident:

---

---

---

List the names of persons who witnessed the exposure/injury incident:

---

---

---

Possible cause of the exposure/injury:

What was the name and title of the field team leader or immediate supervisor at the site of the accident?

---

Was the operation being conducted under an established Safety Plan?

Yes \_\_\_\_ No \_\_\_\_ If Yes, attach a copy. If no, explain.

---

Describe protective equipment and clothing used by the employee:

---

---

---

Other information, comments (Attach relative data if necessary):

---

---

---

Did any limitations in safety equipment or protective clothing contribute or affect exposure? If so, explain:

---

---

---

# **Appendix F**

## **Personal Protective Equipment Instructions**

## **Personal Protective Equipment Instructions**

### **I. Respirator Instructions**

**A. Respirator Checkout**

**B. Donning Respirator**

**C. Storing Respirator**

### **II. SCBA Instructions**

**A. SCBA Checkout**

**B. Donning SCBA**

**C. Doffing SCBA**

**D. Storing SCBA**

**E. SCBA Monthly Inspection**

### **III. Donning Scott Scat-Pak**

C. Storing Respirator

1. Decontaminate and sanitize respirator.
2. Store respirator in a clean plastic bag for protection.



- Close mainline valve. .
- Remove hand from regulator outlet.
- Open by-pass valve slowly to assure proper function.
- Close by-pass valve.
- Cover regulator outlet again with palm of hand.
- Open mainline valve.
- Note pressure reading on regulator gauge.
- Close cylinder valve while keeping hand over regulator outlet.
- Slowly remove hand from outlet and allow air to flow.
- Note pressure when low-pressure warning alarm sounds; it should be between 550-650 psi.
- Remove hand from regulator outlet.
- Close mainline valve.
- Check regulator for leaks; blow air into regulator for 5-10 seconds; suck air from outlet for 5-10 seconds. If a positive pressure or vacuum cannot be maintained, do not use the SCBA unit because it is leaking.

#### B. Donning SCBA

1. Conduct SCBA checkout.
2. Place SCBA air cylinder on back with assistance of buddy or site safety officer.
3. Secure shoulder and waist straps on harness assembly.
4. Don respirator (see respirator instructions).
5. Open cylinder valve by turning valve as far as possible.

### III. DONNING SCOTT SCAT-PAK

1. Lift flap and remove hood from pouch.
2. Turn valve on by turning knob counterclockwise.
3. Remove and discard other respirator (if one is being worn).
4. Slip hood over head, making sure that hose outlet is in front of face.
5. Pull drawstring tight and adjust elastic neck band.

# **Appendix G**

## **Medical Surveillance Certificates**

**TO BE SUBMITTED BY THE CONTRACTOR**

# **Appendix H**

## **Employee Training Certificates**

TO BE SUBMITTED BY THE CONTRACTOR

# **Appendix I**

## **Threshold Limit Value Data**

TLV DATA TO BE SUBMITTED UPON COMPLETION OF  
THE LABORATORY BENCH SCALE TESTING RESULTS  
AND UPON THE REVIEW OF THE TOXICOLOGIST.



# **Appendix J**

## **Site Safety Personnel Resumes**

**TO BE SUBMITTED BY THE CONTRACTOR**

# **Appendix K**

**Chapter 5 (Medical Program)  
of "Occupational Safety and  
Health Guidance Manual for  
Hazardous Waste Site Activities"**

**NIOSH/OSHA/USCG/EPA**

# **Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities**



**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES**  
Public Health Service  
Centers for Disease Control  
National Institute for Occupational Safety and Health

## 5. Medical Program

### Contents

Introduction	5-1
Developing a Program	5-1
Pre-Employment Screening	5-5
Determination of Fitness for Duty	5-5
Baseline Data for Future Exposures	5-6
Sample Pre-Employment Examination	5-7
Periodic Medical Examinations	5-7
Periodic Screening	5-7
Sample Periodic Medical Examination	5-8
Termination Examination	5-8
Emergency Treatment	5-8
Non-Emergency Treatment	5-9
Medical Records	5-9
Program Review	5-10
References	5-10

### Introduction

Workers handling hazardous wastes can experience high levels of stress. Their daily tasks may expose them to toxic chemicals, safety hazards, biologic hazards, and radiation. They may develop heat stress while wearing protective equipment or working under temperature extremes, or face life-threatening emergencies such as explosions and fires. Therefore, a medical program is essential to assess and monitor workers' health and fitness both prior to employment and during the course of work; to provide emergency and other treatment as needed; and to keep accurate records for future reference. In addition, OSHA recommends a medical evaluation for employees required to wear a respirator (29 CFR Part 1910.134(b)(10)), and certain OSHA standards include specific medical requirements (e.g., 29 CFR Part 1910.95 and 29 CFR Parts 1910.1001 through 1910.1045). Information from a site medical program may also be used to conduct future epidemiological studies; to adjudicate claims; to provide evidence in litigation; and to report workers' medical conditions to federal, state, and local agencies, as required by law.

This chapter presents general guidelines for designing a medical program for personnel at hazardous waste sites. It includes information and sample protocols for pre-employment screening and periodic medical examinations, guidelines for emergency and non-emergency treatment, and recommendations for program recordkeeping and review. In addition, it supplies a table of some common chemical toxicants found at hazardous waste sites with recommended medical monitoring procedures.

The recommendations in this chapter assume that workers will have adequate protection from exposures through administrative and engineering controls, and appropriate personal protective equipment and decontamination procedures, as described elsewhere in this manual. Medical surveillance should be used to comple-

### Developing a Program

A medical program should be developed for each site based on the specific needs, location, and potential exposures of employees at the site. The program should be designed by an experienced occupational health physician or other qualified occupational health consultant in conjunction with the Site Safety Officer. The director of a site medical program should be a physician who is board-certified in occupational medicine or a medical doctor who has had extensive experience managing occupational health services. A director and/or examining physician with such qualifications may be difficult to find, due to the shortage of doctors trained in occupational medicine in remote geographic areas where many hazardous waste sites are located. If an occupational health physician is not available, the site medical program may be managed, and relevant examinations performed, by a local physician with assistance from an occupational medicine consultant. These functions may also be performed by a qualified Registered Nurse, preferably an Occupational Health Nurse, under the direction of a suitably qualified physician who has responsibility for the program.<sup>1</sup>

All medical test analyses should be performed by a laboratory that has demonstrated satisfactory performance in an established interlaboratory testing program (1). The clinical or diagnostic laboratory to which samples are sent should meet either (1) minimum requirements under the Clinical Laboratories Improvement Act of 1967 (42 CFR Part 74 Subpart M Section 263(a)), or (2) the conditions for coverage under Medicare. These programs are administered by the Health Care Financing Administration (HCFA), U.S. Department of Health and Human Services (DHHS).

A site medical program should provide the following components:

- Surveillance:
  - Pre-employment screening.
  - Periodic medical examinations (and followup examinations when appropriate).
  - Termination examination.
- Treatment:
  - Emergency
  - Non-emergency (on a case-by-case basis)
- Recordkeeping.
- Program review.

Table 5-1 outlines a recommended medical program; screening and examination protocols are described in the following sections. These recommendations are based on known health risks for hazardous waste workers, a review of available data on their exposures, and an assessment of several established medical programs. Because conditions and hazards vary considerably at each site, only general guidelines are given.

The effectiveness of a medical program depends on active worker involvement. In addition, management should have a firm commitment to worker health and

<sup>1</sup> Certified, state-licensed (where required) Physician's Assistant may also perform these examinations if a physician is available on the premises.

Table 5-2. Common Chemical Toxicants Found at Hazardous Waste Sites, Their Health Effects and Medical Monitoring

HAZARDOUS SUBSTANCE OR CHEMICAL GROUP	COMPOUNDS	USES	TARGET ORGANS	POTENTIAL HEALTH EFFECTS	MEDICAL MONITORING
Aromatic Hydrocarbons	Benzene	Commercial solvents and intermediates for synthesis in the chemical and pharmaceutical industries.	Blood	<p>All cause:</p> <p>CNS<sup>a</sup> depression: decreased alertness, headache, sleepiness, loss of consciousness.</p> <p>Defatting dermatitis.</p> <p>Benzene suppresses bone-marrow function, causing blood changes. Chronic exposure can cause leukemia.</p> <p>Note: Because other aromatic hydrocarbons may be contaminated with benzene during distillation, benzene-related health effects should be considered when exposure to any of these agents is suspected.</p>	<p>Occupational/general medical history emphasizing prior exposure to these or other toxic agents.</p> <p>Medical examination with focus on liver, kidney, nervous system, and skin.</p> <p>Laboratory testing:</p> <p>CBC<sup>b</sup></p> <p>Platelet count</p> <p>Measurement of kidney and liver function.</p>
	Ethyl benzene		Bone marrow		
	Toluene		CNS <sup>a</sup>		
	Xylene		Eyes		
			Respiratory system		
			Skin		
			Liver		
			Kidney		
Asbestos (or asbestiform particles)		<p>A variety of industrial uses, including:</p> <p>Building</p> <p>Construction</p> <p>Cement work</p> <p>Insulation</p> <p>Fireproofing</p> <p>Pipes and ducts for water, air, and chemicals</p> <p>Automobile brake pads and linings</p>	<p>Lungs</p> <p>Gastrointestinal system</p>	<p>Chronic effects:</p> <p>Lung cancer</p> <p>Mesothelioma</p> <p>Asbestosis</p> <p>Gastrointestinal malignancies</p> <p>Asbestos exposure coupled with cigarette smoking has been shown to have a synergistic effect in the development of lung cancer.</p>	<p>History and physical examination should focus on the lungs and gastrointestinal system.</p> <p>Laboratory tests should include a stool test for occult blood evaluation as a check for possible hidden gastrointestinal malignancy.</p> <p>A high quality chest X-ray and pulmonary function test may help to identify long-term changes associated with asbestos diseases; however, early identification of low-dose exposure is unlikely.</p>
Dioxin (see Herbicides)					
Halogenated Aliphatic Hydrocarbons	Carbon tetrachloride	Commercial solvents and intermediates in organic synthesis.	CNS <sup>a</sup>	<p>All cause:</p> <p>CNS<sup>a</sup> depression: decreased alertness, headaches, sleepiness, loss of consciousness.</p> <p>Kidney changes: decreased urine flow, swelling (especially around eyes), anemia.</p> <p>Liver changes: fatigue, malaise, dark urine, liver enlargement, jaundice.</p> <p>Vinyl chloride is a known carcinogen; several others in this group are potential carcinogens.</p>	<p>Occupational/general medical history emphasizing prior exposure to these or other toxic agents.</p> <p>Medical examination with focus on liver, kidney, nervous system, and skin.</p> <p>Laboratory testing for liver and kidney function; carboxyhemoglobin where relevant.</p>
	Chloroform		Kidney		
	Ethyl bromide		Liver		
	Ethyl chloride		Skin		
	Ethylene dibromide				
	Ethylene dichloride				
	Methyl chloride				
	Methyl chloroform				
	Methylene chloride				
	Tetrachloroethane				
	Tetrachloroethylene (perchloroethylene)				
	Trichloroethylene				
	Vinyl chloride				

Table 5-2. (cont.)

HAZARDOUS SUBSTANCE OR CHEMICAL GROUP	COMPOUNDS	USES	TARGET ORGANS	POTENTIAL HEALTH EFFECTS	MEDICAL MONITORING
Organo- phosphate and Carbamate Insecticides	Organophosphate:	Pest control.	CNS <sup>a</sup> Liver Kidney	All cause a chain of internal reactions leading to neuro-muscular blockage. Depending on the extent of poisoning, acute symptoms range from headaches, fatigue, dizziness, increased salivation and crying, profuse sweating, nausea, vomiting, cramps, and diarrhea to tightness in the chest, muscle twitching, and slowing of the heartbeat. Severe cases may result in rapid onset of unconsciousness and seizures. A delayed effect may be weakness and numbness in the feet and hands. Long-term, permanent nerve damage is possible.	Physical exam should focus on the nervous system.  Laboratory tests should include:  RBC <sup>d</sup> cholinesterase levels for recent exposure (plasma cholinesterase for acute exposures).  Measurement of delayed neurotoxicity and other effects.
	Diazinon				
	Dichlorvos				
	Dimethoate				
	Trichlorfon				
	Malathion				
	Methyl parathion				
	Parathion				
	Carbamate:				
	Aldicarb				
	Baygon				
	Zectran				
Polychlorinated Biphenyls (PCBs)		Wide variety of industrial uses.	Liver CNS <sup>a</sup> (speculative) Respiratory system (speculative) Skin	Various skin ailments, including chloracne; may cause liver toxicity; carcinogenic to animals.	Physical exam should focus on the skin and liver.  Laboratory tests include:  Serum PCB levels. Triglycerides and cholesterol.  Measurement of liver function.

<sup>a</sup>CNS = Central nervous system.

<sup>b</sup>CBC = Complete blood count.

<sup>c</sup>Long-term effects generally manifest in 10 to 30 years.

<sup>d</sup>RBC = Red blood count.

In compiling a testing protocol, bear in mind that standard occupational medical tests were developed in factories and other enclosed industrial environments, and were based on the presence of specific identifiable toxic chemicals and the possibility of a significant degree of exposure. Some of these tests may not be totally appropriate for hazardous waste sites, since available data suggest that site workers have low-level exposures to many chemicals concurrently, plus brief high-level exposure to some chemicals [2]. In addition, most testing recommendations, even those for specific toxic substances, have not been critically evaluated for efficacy.

Another important factor to consider is that risk can vary, not only with the type, amount and duration of exposure, but also with individual factors such as age, sex, weight, stress, diet, susceptibility to allergic-type reactions, medications taken, and offsite exposures (e.g., in hobbies such as furniture refinishing and automotive body work).

### Pre-Employment Screening

Pre-employment screening has two major functions: (1) determination of an individual's fitness for duty, including the ability to work while wearing protective

equipment, and (2) provision of baseline data for comparison with future medical data. These functions are discussed below. In addition, a sample pre-employment examination is described.

### Determination of Fitness for Duty

Workers at hazardous waste sites are often required to perform strenuous tasks (e.g., moving 55-gallon drums) and wear personal protective equipment, such as respirators and protective clothing, that may cause heat stress and other problems (see Chapter 8 for details). To ensure that prospective employees are able to meet work requirements, the pre-employment screening should focus on the following areas:

### Occupational and Medical History

- Make sure the worker fills out an occupational and medical history questionnaire. Review the questionnaire before seeing the worker. In the examining room, discuss the questionnaire with the worker, paying special attention to prior occupational exposures to chemical and physical hazards.
- Review past illnesses and chronic diseases, particularly atopic diseases such as eczema and asthma, lung diseases, and cardiovascular disease.

### Sample Pre-Employment Examination

#### Occupational and Medical History

- Do a complete medical history emphasizing these systems: nervous, skin, lung, blood-forming, cardiovascular, gastrointestinal, genitourinary, reproductive, ear, nose, and throat.

#### Physical Examination

Include at least the following:

- Height, weight, temperature, pulse, respiration, and blood pressure.
- Head, nose, and throat.
- Eyes. Include vision tests that measure refraction, depth perception, and color vision. These tests should be administered by a qualified technician or physician. Vision quality is essential to safety, the accurate reading of instruments and labels, the avoidance of physical hazards, and for appropriate response to color-coded labels and signals.
- Ears. Include audiometric tests, performed at 500, 1,000, 2,000, 3,000, 4,000, and 6,000 hertz (Hz) pure tone in an approved booth (see requirements listed in 29 CFR Part 1910.95, Appendix D). Tests should be administered by a qualified technician, and results read by a certified audiologist or a physician familiar with audiometric evaluation. The integrity of the eardrum should be established since perforated eardrums can provide a route of entry for chemicals into the body. The physician evaluating employees with perforated eardrums should consider the environmental conditions of the job and discuss possible specific safety controls with the Site Safety Officer, industrial hygienist, and/or other health professionals before deciding whether such individuals can safely work on site.
- Chest (heart and lungs).
- Peripheral vascular system.
- Abdomen and rectum (including hernia exam).
- Spine and other components of the musculoskeletal system.
- Genitourinary system.
- Skin.
- Nervous system.

#### Tests

- Blood.
- Urine.
- A 14 x 17-inch posterior/anterior view chest X-ray, with lateral or oblique views only if indicated or if mandated by state regulations. The X-ray should be taken by a certified radiology technician and interpreted by a board-certified or board-eligible radiologist. Chest X-rays taken in the last 12-month period, as well as the oldest chest X-ray available, should be obtained and used for comparison. Chest X-rays should not be repeated more than once a year, unless otherwise determined by the examining physician.

ing protective equipment, additional tests may be necessary, for example:

- Pulmonary function testing. Measurement should include forced expiratory volume in 1 second (FEV<sub>1</sub>), forced vital capacity (FVC), and FEV<sub>1</sub>-to-FVC ratio, with interpretation and comparison to normal predicted values corrected for age, height, race, and sex. Other factors such as FEF, MEFR, MVV, FRC, RV, and TLC<sup>1</sup> may be included for additional information. A permanent record of flow curves should be placed in the worker's medical records. The tests should be conducted by a certified technician and the results interpreted by a physician.
- Electrocardiogram (EKG). At least one standard, 12-lead resting EKG should be performed at the discretion of the physician. A "stress test" (graded exercise) may be administered at the discretion of the examining physician, particularly where heat stress may occur.

#### Baseline Monitoring

If there is likelihood of potential onsite exposure to a particular toxicant, specific baseline monitoring should be performed to establish data relating to that toxicant.

### Periodic Medical Examinations

#### Periodic Screening

Periodic medical examinations should be developed and used in conjunction with pre-employment screening examinations. Comparison of sequential medical reports with baseline data is essential to determine biologic trends that may mark early signs of adverse health effects, and thereby facilitate appropriate protective measures.

The frequency and content of examinations will vary, depending on the nature of the work and exposures. Generally, medical examinations have been recommended at least yearly. More frequent examinations may be necessary, depending on the extent of potential or actual exposure, the type of chemicals involved, the duration of the work assignment, and the individual worker's profile. For example, workers participating in the cleanup of a PCB-contaminated building were initially examined monthly for serum PCB levels. Review of the data from the first few months revealed no appreciable evidence of PCB exposure. The frequency of PCB testing was then reduced [4]. Periodic screening exams can include:

- Interval medical history, focusing on changes in health status, illnesses, and possible work-related symptoms. The examining physician should have information about the worker's interval exposure history, including exposure monitoring at the job site, supplemented by worker-reported exposure history and general information on possible exposures at previously worked sites.
- Physical examination.

**Ability to Perform While Wearing Protective Equipment**  
To determine a worker's capacity to perform while wear-

<sup>1</sup> FEF = forced expiratory flow; MEFR = maximal expiratory flow rate; MVV = maximal voluntary ventilation; FRC = functional residual capacity; RV = residual volume; TLC = total lung capacity.



**Table 5-4. Signs and Symptoms of Chemical Exposure and Heat Stress that Indicate Potential Medical Emergencies**

TYPE OF HAZARD	SIGNS AND SYMPTOMS
Chemical Hazard	Behavioral changes
	Breathing difficulties
	Changes in complexion or skin color
	Coordination difficulties
	Coughing
	Dizziness
	Droping
	Diarrhea
	Fatigue and/or weakness
	Irritability
	Irritation of eyes, nose, respiratory tract, skin, or throat
	Headache
	Light-headedness
	Nausea
	Sneezing
	Sweating
	Tearing
	Tightness in the chest
Heat Exhaustion	Clammy skin
	Confusion
	Dizziness
	Fainting
	Fatigue
	Heat rash
	Light-headedness
	Nausea
	Profuse sweating
	Slurred speech
Heat Stroke (may be fatal)	Weak pulse
	Confusion
	Convulsions
	Hot skin, high temperature (yet may feel chilled)
	Incoherent speech
	Convulsions
	Staggering gait
	Sweating stops (yet residual sweat may be present)
	Unconsciousness

Depending on the site's location and potential hazards, it may be important to identify additional medical facilities capable of sophisticated response to chemical or other exposures.

- Post conspicuously (with duplicates near the telephones) the names, phone numbers, addresses, and procedures for contacting:
  - On-call physicians.
  - Medical specialists.
  - Ambulance services.
  - Medical facility(ies).
  - Emergency, fire, and police services.
  - Poison control hotline.
- Provide maps and directions.
- Make sure at least all managers and all individuals involved in medical response know the way to the nearest emergency medical facility.
- Establish a radiocommunication system for emergency use.
- Review emergency procedures daily with all site personnel at safety meetings before beginning the work shift.

### Non-Emergency Treatment

Arrangements should be made for non-emergency medical care for hazardous waste site workers who are experiencing health effects resulting from an exposure to hazardous substances. In conjunction with the medical surveillance program, offsite medical care should ensure that any potential job-related symptoms or illnesses are evaluated in the context of the worker's exposure. Offsite medical personnel should also investigate and treat non-job-related illnesses that may put the worker at risk because of task requirements (e.g., a bad cold or flu that might interfere with respirator use). A copy of the worker's medical records should be kept at the site (with provisions for security and confidentiality) and, when appropriate, at a nearby hospital. Treating physicians should have access to these records.

### Medical Records

Proper recordkeeping is essential at hazardous waste sites because of the nature of the work and risks: employees may work at a large number of geographically separate sites during their careers, and adverse effects of long-term exposure may not become apparent for many years. Records enable subsequent medical care providers to be informed about workers' previous and current exposures.

Occupational Safety and Health Administration (OSHA) regulations mandate that, unless a specific occupational safety and health standard provides a different time period, the employer must:

- Maintain and preserve medical records on exposed workers for 30 years after they leave employment (29 CFR Part 1910.20).

# **Appendix L**

**29 CFR Part 1910.120  
December 19, 1986**

**Final Rule**

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**Friday  
December 19, 1986**

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**Part IV**

**Department of Labor**

**Occupational Safety and Health  
Administration**

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**29 CFR Part 1910  
Hazardous Waste Operations and  
Emergency Response; Interim Final Rule**

**DEPARTMENT OF LABOR****Occupational Safety and Health Administration****29 CFR Part 1910****[Docket No. S-760]****Hazardous Waste Operations and Emergency Response****AGENCY:** Occupational Safety and Health Administration; Labor.**ACTION:** Interim final rule.

**SUMMARY:** This interim final rule amends the Occupational Safety and Health Administration (OSHA) standards for hazardous materials in Subpart H of 29 CFR Part 1910 by adding a new § 1910.120 containing employee protection requirements for workers engaged in hazardous waste operations including emergency response to hazardous substance incidents.

Coverage includes employees involved in responses covered by the Comprehensive Environmental Response, Compensation and Liability Act of 1980 as amended (CERCLA or "Superfund" Act) [Pub. L. 96-510, 42 U.S.C. 9601 *et seq.*, 94 Stat 2767] such as clean-up of hazardous waste sites, certain hazardous waste operations conducted under the Resource Conservation and Recovery Act of 1976 as amended (RCRA) [Pub. L. 94-580, 42 U.S.C. 6901 *et seq.*, 90 Stat 2795], and emergency response to incidents involving the handling, processing and transportation of hazardous substances.

The issuance of this interim final rule is mandated by section 128(e) of the "Superfund Amendments and Reauthorization Act of 1986" (SARA) [Pub. L. 99-499]. The interim final rule will regulate employee safety and health at hazardous waste operations and during emergency response to hazardous substance incidents until a final standard, also mandated by section 128 of SARA, is issued by OSHA and becomes effective. The final OSHA standard also mandated by section 128 of SARA is the subject of a Notice of Proposed Rulemaking which will be published shortly.

**DATES:** Interim rule effective December 19, 1986; various start-up dates have been established in paragraph (p) of the standard. The incorporation by reference of certain publications listed in the regulations is approved by the Director of the Federal Register as of December 19, 1986.

**FOR FURTHER INFORMATION CONTACT:** Mr. James F. Foster, U.S. Department of Labor, Occupational Safety and Health Administration, Division of Consumer

Affairs, Room S-4220, 200 Constitution Avenue, NW., Washington, DC 20210, 202-523-8151.

This interim final rule was prepared by Michael B. Moore and Chappell D. Pierce, Directorate of Safety Standards, Office of Fire Protection Engineering and Systems Safety Standards, (202) 523-7225.

**SUPPLEMENTARY INFORMATION:****I. Background**

On October 17, 1986, the President signed into law the "Superfund Amendments and Reauthorization Act of 1986" (SARA) [Pub. L. 99-499]. As part of SARA the Secretary of Labor ("Secretary") is directed to issue an interim final rule within 60 days after the date of enactment, which is to provide no less protection for workers engaged in covered operations than the protections contained in the Environmental Protection Agency's (EPA), "Health and Safety Requirements for Employees Engaged in Field Activities" manual (EPA Order 1440.2) dated 1981 and the existing OSHA standards under Subpart C of 29 CFR Part 1928. SARA also directs the Secretary to issue, within one year, a final standard under section 8(b) of the Occupational Safety and Health Act of 1970 for the health and safety of employees engaged in hazardous waste operations. SARA further indicates that certain specific areas of employee protection (i.e., medical surveillance, personal protective equipment, training, and others) contained in section 128(b) are relevant to protect employees engaged in hazardous waste operations.

The interim final rule issued today becomes effective immediately and will remain in effect until one year after issuance of the final OSHA standard, which will be proposed shortly. Congress has clearly directed in section 128(e) that these interim final rules become effective upon issuance and the standard provider this. Implementation is to commence immediately, however, various start-up dates are set forth in paragraph (p) of the standard which recognize that full implementation cannot be completed immediately for some provisions. In addition OSHA will, of course, recognize greater feasibility constraints in the first three months of the standard and take those constraints into account in enforcement.

This interim final rule has been adopted from the language of the EPA manual entitled "Health and Safety Requirements for Employees Engaged in Field Activities" (1981) and the language of OSHA's safety and health standards in Subpart C of 29 CFR Part 1928. The interim final rule also contains language

taken from various documents issued either jointly or solely by the EPA, OSHA, the U.S. Coast Guard, and the National Institute for Occupational Safety and Health (NIOSH). OSHA has specifically used the joint OSHA/EPA/USCG/NIOSH document entitled, "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities" (Preamble Reference 6), as an outline in preparing this interim rule. This four agency manual has been developed as a result of the collaborative efforts of professionals representing the four agencies. These professionals, who are knowledgeable in hazardous waste operations, worked with over 100 experts and organizations in the development of the criteria contained in this manual. The manual was published in October 1985 and is public information. The manual is a guidance document for managers responsible for occupational safety and health programs at inactive hazardous waste sites. The manual is intended for use by government officials at all levels and contractors involved with hazardous waste operations. The manual provides general guidance and is intended to be used as a preliminary basis for developing a specific health and safety program for hazardous waste operations. Further the major subject areas listed in SARA section 128(b) are nearly identical to these major chapters listed in the manual.

Congress indicated that reasonably comprehensive protection was intended for employees at hazardous waste operations, as discussed below, covering more than the minimum requirements specified in the EPA manual (EPA Order 1440.2) and Subpart C of 29 CFR Part 1928. In light of the short period of time Congress directed for issuance of this standard, OSHA's utilization of recognized sources of guidance which have been created by experts in the area and utilizing the resources of relevant agencies is appropriate.

In view of the brief period given for the issuance of this document, it may be necessary to issue minor corrections in the near future.

**II. Summary and Explanation of the Standard****Paragraph (a)—Scope, Application, and Definitions**

In paragraph (a)(1), *Scope*, OSHA has defined the scope of the standard to include:

(i) Hazardous substance response operations under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980

Most of the requirements of the interim rule apply to clean-up activities of hazardous substances or hazardous wastes at CERCLA sites, corrective actions at RCRA sites, and clean-up operations of hazardous substances at emergency incidents after emergency response personnel have concluded their duties.

The employer must also comply with the standards in 29 CFR Parts 1910 and 1926, as well as with the requirements specifically covered in this interim rule. If there is a conflict or overlap, the more protective provisions are to apply. Since this interim rule does not cover all of the hazards present at hazardous waste operations, other OSHA standards in Parts 1910 and 1926 apply also. Other OSHA standards cover many other hazards, and OSHA wants to make clear that the other standards continue to apply. Also, hazardous waste operators who are not within the scope of this standard are covered by the Parts 1910 and 1926 standards.

In paragraph (a)(3), *Definitions*, OSHA has defined various terms used in this rulemaking. The definitions for hazardous substances and hazardous wastes have been taken from the U.S. Environmental Protection Agency (EPA) and U.S. Department of Transportation (DOT) regulations. This has been done to assure consistency and compatibility between this interim rule and the rules and regulations of the EPA and DOT. The remaining definitions have been taken for the most part from SARA, the four agency manual (Reference 6) or existing OSHA standards.

The term "established permissible exposure limit" is defined to give direction as to the appropriate degree of protection needed to be achieved by personal protective equipment and other similar purposes.

#### *Paragraph (b)—General Requirements*

In paragraph (b), *General requirements*, OSHA sets forth for the most part a summary of requirements which are specified in detail in later paragraphs. The preamble discussion for later paragraphs sets forth the reasons for the various provisions. Many of these requirements are part of the minimum requirements which Congress directed OSHA to issue in section 126(e) of SARA. The EPA manual (EPA Order 1440.2) referenced in section 126(e) requires extensive training and medical surveillance programs. Subpart C of 29 CFR Part 1926, also referenced, requires, in addition, accident prevention programs (§ 1926.20(b)), use of appropriate personal protective equipment (§ 1926.28), sanitation and illumination requirements (§§ 1926.26

and 1926.27), provisions on safe handling of toxic substances (§ 1926.21(b)(5)), precautions in confined spaces (§ 1926.21(b)(6)) and similar provisions. Congress also directed additional provisions for the proposed regulation, which are considered relevant for the interim regulation. These include engineering controls, maximum exposure limits and monitoring, handling requirements, decontamination procedures and emergency response. Based on this comprehensive statutory direction OSHA believes that the intent of Congress is to have employers implement a safety and health program that will address the recognized serious hazards to employees involved in hazardous waste operations. Therefore, OSHA has incorporated the more important elements of section 126(b), along with the mandatory provisions of section 126(e) of SARA, into this rule. Each general requirement in paragraph (b) calls for employer action and directs the employer to the specific paragraph of this rule that contains the duties in greater detail.

OSHA believes that these requirements are necessary to assure adequate employee protection to the known hazards faced by employees. The language used in these requirements has been adapted from the various documents listed in the Reference section of this preamble.

Three of the subparagraphs in paragraph (b) do not reference other paragraphs in the regulation. Paragraph (b)(1) requires the employer to develop a safety and health program for hazardous waste operations. Such programs are part of the requirements mandated by SARA for the interim rule. Thus, Subpart C of 29 CFR Part 1926 requires such a program in § 1926.20(b) and EPA Order 1440.2 requires training in "safety plan development" (pg. 5). OSHA's experience also establishes that a safety and health program is necessary to protect employees so that hazards are assessed and control programs are systematically laid out. Prior OSHA section 6(b) health standards require a compliance plan to set forth a health program to protect employees from the hazard.

Paragraph (b)(14) requires compliance with Subpart P of 29 CFR Part 1926 which covers excavation. OSHA considers that those provisions already apply, but they are singled out because they are particularly important to monitor since much excavation activity occurs on hazardous waste sites.

Paragraph (b)(15) requires employers to notify contractors and subcontractors of the hazards identified by the employer at hazardous waste

operations. Sections 126(b)(2) and (e) of SARA indicate Congress's specific interest in protecting employees of contractors and in involving contractors in the safe operation of hazardous waste sites. This provision assists the contractor to become aware of the risks so that the contractor's employees may be better protected.

#### *Paragraph (c)—Site Characterization and Analysis*

For an effective safety and health program, which Congress clearly intends for employees, the employer needs to know the hazards faced by employees in order to develop and implement effective control measures. Site characterization provides the information needed to identify site hazards and to select employee protection methods. The more accurate, detailed, and comprehensive the information available about a site, the more the protective measures can be tailored to the actual hazards that the employees may encounter. Congress clearly intended that such a requirement be included. Subpart C of 29 CFR Part 1926 referenced in section 126(e) of SARA requires "frequent and regular inspections of the job site" (29 CFR 1926.20(b)(2)). Also section 126(b)(1) of SARA provides for site analysis. Also item #9 of the EPA manual (EPA Order 1440.2) addresses this practice.

Site characterization generally proceeds in three phases:

1. Prior to site entry, gather information away from the site, conduct reconnaissance from the site perimeter and conduct offsite characterization.
2. Conduct onsite surveys. During this phase, restrict site entry only to reconnaissance personnel.
3. Once the site has been determined safe for commencement of other activities, continue monitoring to provide an updated source of information about site conditions.

It is important to recognize that site characterization is a continuous process. At each phase of site characterization, information shall be obtained and evaluated to define the potential hazards of the site. This assessment shall be used to develop a safety and health plan for the next phase of work. In addition to the formal information gathering that takes place during the phases of site characterization described here, all site personnel should be constantly alert for new information about site conditions. Other requirements of this section have been adopted from reference 6.

for 30 or more days in a 12-month period or who wear respirators 30 days during the year. These are the employees who will be at greater health risk and employees who wear respirators need to be examined to determine whether they can safely do so as a routine matter. Some dividing line is needed, because employees who might be present on a hazardous waste site only a few days a year or working in areas such as offices or the periphery where exposures are low would not normally benefit from medical surveillance as their likely cumulative exposures to toxic chemicals would be very low probably not significantly higher than the general population. The EPA manual indicates some dividing line is appropriate because it directs medical surveillance only for employees "routinely" exposed.

Wearing respirators for any part of each of 30 days will require medical surveillance because it indicates routine exposure to toxic chemicals. There is no requirement that there be 240 hours of respirator use before medical surveillance is required. Similarly being exposed over established safe levels to several chemicals each for less than 30 days but totalling more than 30 days per year requires medical surveillance. This indicates routine exposures to hazardous substances and also combinations of chemicals may cause synergistic effects creating greater health hazards than an individual chemical.

OSHA has based many of the details of medical surveillance on its experience in issuing health standards under section 6(b) of the OSH Act and as directed by section 6(b)(7) of the Act. Congress would be knowledgeable that medical surveillance requirements in these standards represent OSHA's expert judgement of what is an appropriate medical surveillance program.

The appropriate medical tests and examinations depend on the substances an employee is exposed to and whether the employee wears a respirator. As employees on hazardous waste sites will be exposed to differing substances, the paragraph can not specifically state the required tests. Consequently the paragraph states that the employer provide to the physician information on exposures, respirator use, and duties on the site. The physician is then to determine the appropriate medical surveillance protocol in terms of specific tests and examinations. By the employer specifying duties the physician also can judge whether the employee can handle the arduousness of the work.

In situations where most of the employees on the site have similar

exposures the protocol may be similar for all employees. Where different groups of employees on the site have substantially different exposures, several different protocols may be appropriate for the site's workers depending on exposures.

There are a number of sources for guidance on specific medical examination protocols. Chapter 5 of Reference 6 provides such guidance by groups of chemicals likely to be present on a site. It references other authorities. The manual should be supplied to the physician. It is also a basis for the medical surveillance program required by this paragraph. In addition, the EPA medical monitoring program guidelines referenced by the EPA manual provides guidance on specific protocols.

The paragraph requires an initial or baseline medical examination either prior to the start up date for employees who are currently working at hazardous waste sites or prior to initial assignment to an area where medical examinations will be required. The purpose is to take a detailed medical history and where possible develop a health baseline prior to any exposures so as to be able to evaluate changes which may be connected to hazardous substance exposures. In addition the initial examination will permit evaluation of whether the employee can appropriately wear respirators and whether the employee has preexisting conditions which would make exposure to hazardous substances inappropriate. An initial examination has been required by other OSHA health standards and is recommended in Reference 6.

The physician must be informed of what type of respirators and personal protective equipment an employee is likely to wear. The medical examination is to include appropriate tests to evaluate the employee's ability to wear respirators and PPE.

The physician will also specify the protocol of the periodic examinations. These may be different from the initial examination, for example, only an updated medical history would be required. The periodic examinations are required yearly. OSHA's experience in other health standards has been that this is an appropriate period and it is also recommended by Reference 6. EPA's medical monitoring program guidelines cross referenced in the EPA manual recommends baseline annual examination generally and a termination examination. It is reasonable to determine periodically whether exposures have brought medical changes and to identify conditions caused by chemicals at an early stage to permit more effective treatment. In some

circumstances, the physician may advise more frequent examinations.

Examinations are also to be provided when the employee brings to the employer's attention signs or symptoms indicating possible overexposure to hazardous substances. The employee is to be trained in recognizing what symptoms may indicate substances to which the employee is exposed. Examples may be dizziness or rashes. Examinations are also required, when medically appropriate, during emergencies when exposure to higher levels is possible. For example, a urinary phenol test is appropriate for employees exposed to high levels of benzene in an emergency.

Finally, a medical examination is required for employees who have been required to have medical examinations upon termination of employment or reassignment to an area where medical examinations are not required. This is to detect conditions which have developed prior to departure and is recommended by the EPA program.

The medical examination is to be provided under the supervision of a licensed physician, i.e., the person must be qualified to make medical judgements. As provided by section 6(b)(7) of the OSH Act, the employer is to pay the cost of the examination. In addition provisions are included so that the employee is not discouraged from taking the examination. The exam is to be given at a reasonable time and place. If given during regular working hours the employee shall receive the employer's normal pay for that time. If the exam is given outside regular working hours, the employee shall be paid his regular wages for the time spent taking and waiting for the examination.

The physician shall make a report to the employer of medical conditions which may make the employee at increased risk to work at the site and any recommendations on limitations on use of respirators and other PPE as a result of the medical conditions. This will provide guidance for the safe employment of the employee at the site. The physician shall not reveal diagnoses or conditions unrelated to employment, but shall inform the employee directly of those conditions and any and all occupationally related conditions.

The medical paragraph requires that appropriate records be kept to assist in future evaluation of the employee's health. Secondly, this information may assist in research on occupational related disease. Records should be kept pursuant to the provisions of 29 CFR 1910.20. Full consideration was given in



whether engineering controls can achieve permissible exposure limits and which controls to use, delineating areas where protection is needed, assessing the potential health effects of exposure, and determining the need for specific medical monitoring. As mentioned above, section 128(e) of SARA mandates the use of PPE by its direction that at a minimum the requirements of the EPA manual and Subpart C be followed. Those include requirements for use of PPE. But PPE cannot be effectively used unless monitoring has identified the type of PPE to be used. This is a further reason to include this provision in the interim final rule.

The language of this paragraph was adapted from reference 6.

**Paragraph (i)—Informational Programs**

In paragraph (i), *Informational Programs*, OSHA is requiring employers, as part of their safety and health program, to develop and implement a site specific safety and health plan for each hazardous waste operation site.

The site safety and health plan shall be developed by the employer, utilizing the other parts of the organizational plan and the employer's safety and health program. The site safety and health plan will address the anticipated safety and health hazards of each work operation or activity and the means to eliminate the hazards or to effectively control them to prevent injury or illness.

This site safety and health plan is to include: (1) The names of those responsible for assuring that safe and healthful practices and procedures are followed on the whole site; (2) risk analysis or systems analysis for specific work tasks or operations on the site; (3) employee training assignments both off site and on-the-job training on site; (4) the list of required personal protective equipment needed for each work task and operation on site; (5) the employer's medical surveillance program for the site; (6) the methods for identification and characterization of safety and health hazards on the site including the monitoring procedures that will be done throughout the work on site; (7) site control measures including those for establishing work zones on the site; (8) the necessary decontamination procedures which are matched to the kinds of anticipated contaminants to be cleaned from employees and equipment; (9) the standard operating procedures to be used by employees on site; and (10) the contingency plan for emergencies and confined space entry procedures. Safety meetings and briefings and site inspections shall also be mentioned in the plan as well as the procedures to be

followed in changing or modifying the plan.

The site safety and health plan is necessary to protect employee health. There are many hazards at a hazardous waste operation which need to be determined and addressed. The plan provides that this will be done in a systematic manner so that hazards will not be missed and so that needed protective action will not be overlooked. The approach used has been adapted from reference 6.

**Paragraph (j)—Handling Drums and Containers**

The handling of drums and containers at hazardous waste sites poses one of the greatest dangers to hazardous waste site employees. Hazards include detonations, fires, explosions, vapor generation, and physical injury resulting from moving heavy containers by hand and working around stacked drums, heavy equipment, and deteriorated drums. While these hazards are always present, proper work practices can minimize the risks to site personnel. Handling and storage of hazardous substances is addressed in item (a) of the EPA manual.

Containers are handled during characterization and removal of their contents and during other operations. Many of the hazards encountered during the handling of drums occur during the handling of containers. The relative size of a container when compared to the size of a drum is no indication of the degree of hazard posed by the container. They should be treated in accordance with the level of hazard posed by their contents not by their size. The language used in this paragraph was adapted from Reference 6.

**Paragraph (k)—Decontamination**

As part of the care of PPE required by this standard, decontamination is a necessary practice to properly protect those employees who may be exposed to hazardous substances. Decontamination provisions protect an employee from being exposed to hazardous substances which would otherwise be on the employee's PPE when it is removed. The standard requires that a decontamination plan be developed and implemented before any employees or equipment may enter areas on site where potential for exposure to hazardous substances exists.

As required by the standard, decontamination procedures and areas shall be developed to minimize hazardous exposures to employees whose equipment and PPE are being decontaminated, as well as to

employees who are assisting in the decontamination of workers and equipment. These measures are required since without proper procedures and decontamination areas, employees may be unknowingly exposed to hazardous substances which have contacted, or otherwise adhered to equipment and clothing. The standard also requires that all employees, clothing, equipment and decontamination fluids and equipment be decontaminated or disposed of before leaving a contaminated area. These provisions are required so that contaminated persons and materials do not leave the "hot zone" and thereby expose other employees and persons to hazardous substances.

Decontamination methods and cleaning fluids must be matched to the particular hazardous substance at the site in order for the decontamination procedures to be effective in removing the hazards from PPE and other equipment. No one decontamination fluid will be effective for all hazardous substances. As required by the standard the decontamination program must be effective and it must be monitored by the site safety and health officer to maintain its effectiveness. These requirements are included so that employees are not exposed to hazardous substances by reusing PPE and other equipment which are still contaminated.

The language used in this paragraph was adapted from reference 6.

**Paragraph (l)—Emergency Response**

Section 128(e) of SARA specifically discusses protecting "emergency response workers," in addition in the EPA manual under items 4 and 9 and in 29 CFR 1926.23 and 1926.24 call for preparations and planning for emergencies. Congress made its intent clear that emergency planning and response is an important part of any employer's safety and health program and indicated that it is to be addressed in the interim final rule.

In paragraph (l)(1), *Emergency Response, General*, OSHA is requiring employers covered in paragraph (a)(2)(ii), who are involved in hazardous waste operations, as part of their on-site contingency planning to develop and implement an emergency response plan. These employers are to inform all their employees on the waste site about the emergency response plan. The plan is to be available for use prior to the start of work on the site. The plan will be a part of the site safety and health plan. The elements of the emergency response plan will include: (1) Recognition of emergencies; (2) methods or procedures for alerting employees on site; (3)

implementation for some provisions is not feasible immediately. For these provisions, commencement of implementation must begin immediately, but completion of full compliance is required as soon as possible or feasible but in no case later than a specified date, which is no longer than three months.

It is OSHA's judgment that all provisions can be fully implemented by the periods specified. OSHA also believes that the immediate effectiveness provisions specifically apply to the mandatory requirements.

OSHA does not believe that Congress intended that work at current hazardous waste operations stop until implementation of all requirements can be feasibly completed. This paragraph so indicates. However, for new sites, these requirements can be completed in advance. It is not OSHA's intention that emergency actions necessary to protect the public safety and health be prevented because in a particular circumstance it is not feasible to carry out particular requirements of this standard in the time needed to respond to the emergency.

### III. References

1. Superfund Amendments and Reauthorization Act of 1986 (SARA), Pub. L. 99-499.
2. Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA or "Superfund"), Pub. L. 96-510, December 11, 1980, 94 Stat. 2787.
3. Resource Conservation and Recovery Act of 1976 (RCRA), Pub. L. 94-580, October 21, 1976, 90 Stat. 2795.
4. "Health and Safety Requirements for Employees Engaged in Field Activities", Environmental Protection Agency Order 1440.2, U.S. Environmental Protection Agency, July 12, 1981.
5. Subparts C and D of 29 CFR Part 1926.
6. "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities", Occupational Safety and Health Administration, Environmental Protection Agency, U.S. Coast Guard, and National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 85-115, October 1985.

### IV. Regulatory Impact Analysis, Regulatory Flexibility Analysis and Environmental Impact Analysis

OSHA anticipates that this interim final standard will have a significant impact upon employers and their employees who work at CERCLA sites and at some RCRA sites; and who respond to emergency clean-ups of hazardous substance spills. OSHA has had little time since the enactment of SARA to collect information concerning these industries. As a result, the currently available information is

insufficient for OSHA to use to estimate the potential benefits and costs that would occur as a consequence of compliance with this interim final rule. OSHA is collecting additional information to be used in conjunction with the information from the comments that will be received in response to publication of the proposed rule covering hazardous waste operations. This information will be sufficient for OSHA to provide a complete Regulatory Impact Analysis for the final rule that will govern hazardous waste operations.

**Regulatory Flexibility Act Analysis.** The requirements of the Regulatory Flexibility Act are not applicable to this interim final rule, under 5 U.S.C. 603(a), because notice and comment proposed rulemaking under the Administrative Procedures Act, or any other statute, is not required.

**Environmental Impact Analysis.** The National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 *et seq.*), as implemented by the regulations (40 CFR Part 1500) of the Council on Environmental Quality (CEQ), requires that federal agencies assess their regulatory actions to determine if there is a potential for a significant impact on the quality of the human environment and, if necessary, to prepare an environmental impact statement.

In accordance with these requirements and DOL NEPA Compliance Procedures (29 CFR Part 11, Subpart B, section 11.10(a)(4)), OSHA has determined that due to the compressed rulemaking schedule imposed by the Congress in issuing the interim regulation, no environmental impact statement will be prepared for this interim rule.

In similar situations, for example, when an emergency temporary standard (ETS) has been issued, the courts have held that NEPA does not require advance preparation of an environmental statement for an ETS (*Dry Color Manufacturing Association v. U.S. Department of Labor*, 486 F. 2d 98, 107 [3rd Cir. 1973]). This interim final standard is similar in nature to an ETS issued for relatively brief periods for short notice pursuant to section 6(c) of the Occupational Safety and Health Act of 1970 and section 101(b) of the Federal Mine Safety and Health Act of 1977. The DOL NEPA regulations set forth in 29 CFR Part 11, Subpart B, section 11.10(a)(4), provide that in these situations the regulations set forth in 40 CFR Parts 1500 *et seq.* may not be strictly observable.

OSHA, however, will assess the environmental effects of the proposed permanent regulation of hazardous waste sites. The possibility that

increased training related to employee safety and health protection will also affect and reduce inadvertent environmental releases of hazardous substances at waste sites will be analyzed. The results of this study will be available for review and comment prior to the hearing on the proposed permanent standard and will be an appropriate issue for discussion at the public hearings scheduled for the proceeding.

In the interim, OSHA welcomes any comments on any environmental effects that might occur as a result of promulgation of a rule on hazardous waste sites.

### V. International Trade

OSHA has preliminarily concluded that this interim final rule will not significantly affect international trade. The firms that will be primarily affected by this interim final rule deal with hazardous waste products and are not involved in international trade. In addition, the hazardous wastes to be handled under this interim final rule are primarily by products from previously manufactured goods and consequently, any potential costs would not be borne by the goods that are currently being traded. Nevertheless, the information that OSHA is collecting and the information that will be supplied in response to the publication of the proposed rule covering Hazardous Waste Operations will be carefully reviewed and analyzed to establish the potential impacts of the final rule upon international trade.

### VI. State Plan States

This Federal Register document adds an interim final rule (section 1910.120, "Hazardous Waste Operations and Emergency Response") to existing Subpart H of 29 CFR Part 1910, OSHA's general industry standards on hazardous materials. The 25 States with their own OSHA approved occupational safety and health plans must develop a comparable standard applicable to both the private and public (State and local government employees) sectors within six months of the publication date of this interim final rule or show OSHA why there is no need for action, e.g., because an existing state standard covering this area is already "at least as effective" as the new Federal standard. These states are Alaska, Arizona, California, Connecticut (for state and local government employees only), Hawaii, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Nevada, New Mexico, New York (for state and local government employees



1986 incorporated by reference, or if none of the above is specified, a limit based upon a published study or manufacturers' safety data sheet brought to the employer's attention. The two documents incorporated by reference are available for purchase from the following:

NIOSH, Publications Dissemination, Division of Standards Development and Technology Transfer, National Institute for Occupational Safety and Health, 4676 Columbia Parkway, Cincinnati, OH 45228, (513) 841-4287  
American Conference of Governmental Industrial Hygienists, 8500 Glenway Ave., Building D-7, Cincinnati, OH, 45211-4438, (513) 661-7881

and are available for inspection and copying at the OSHA Docket Office, Docket No. S-780, Room N-3871, 200 Constitution Ave., NW., Washington, DC 20210.

**"Hazardous substance"** means any substance designated or listed under (i) through (iv) below, exposure to which results or may result in adverse effects on the health or safety of employees:

- (i) any substance defined under section 101(14) of CERCLA,
- (ii) any biological agent and other disease-causing agent as defined in section 104(a)(2) of CERCLA,
- (iii) any substance listed by the U.S. Department of Transportation and regulated as hazardous materials under 49 CFR 172.101 and appendices, and
- (iv) hazardous waste.

**"Hazardous waste"** means (i) a waste or combination of wastes as defined in 40 CFR 261.3, or (ii) those substances defined in 49 CFR 171.8.

**"Hazardous waste operation"** means any operation involving employee exposure to hazardous wastes, hazardous substances, or any combination of hazardous wastes and hazardous substances that are conducted within the scope of this standard.

**"Hazardous waste site" or "site"** means any facility or location at which hazardous waste operations within the scope of this standard take place.

**"Health hazard"** means a chemical, mixture of chemicals or a pathogen for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the

hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes. Further definition of the terms used above can be found in Appendix A to 29 CFR 1910.1200.

**"IDLH" or "Immediately dangerous to life or health"** means any condition that poses an immediate threat to life, or which is likely to result in acute or immediate severe health effects. This includes oxygen deficiency conditions.

**"Immediate severe health effects"** means any acute clinical sign or symptom of a serious, exposure-related reaction manifested within 72 hours after exposure to a hazardous substance.

**"Oxygen deficiency"** means that concentration of oxygen by volume below which air supplying respiratory protection must be provided. It exists in atmospheres where the percentage of oxygen by volume is less than 19.5 percent oxygen.

**"Site safety and health officer"** means the individual located on a hazardous waste site who is responsible to the employer and has the authority and knowledge necessary to implement the site safety and health plan and verify compliance with applicable safety and health requirements.

(b) **General requirements**—(1) **Safety and health program.** Each employer shall develop and implement a safety and health program for its employees involved in hazardous waste operations. The program, as a minimum, shall incorporate the requirements of this section and be provided, as appropriate, to any subcontractor or its representative who will be involved with the hazardous waste operation. The program shall be designed to identify, evaluate, and control safety and health hazards and provide for emergency response for hazardous waste operations.

(2) **Site characterization and analysis.** Hazardous waste sites shall be evaluated in accordance with paragraph (c) of this section to identify specific site hazards and to determine the appropriate safety and health control procedures needed to protect employees from the identified hazards.

(3) **Site control.** Site control procedures shall be implemented in accordance with paragraph (d) of this section before clean-up work begins to control employee exposure to hazardous substances.

(4) **Training.** Initial or refresher or review training meeting the requirements of paragraph (e) of this section shall be provided to employees before they are permitted to engage in hazardous waste operations that could

expose them to hazardous substances, safety, or health hazards.

(5) **Medical surveillance.** Medical surveillance shall be provided in accordance with paragraph (f) of this section for employees exposed or potentially exposed to hazardous substances or health hazards or who wear respirators.

(6) **Engineering controls, work practices and personal protective equipment.** Engineering controls, work practices, personal protective equipment, or a combination of these shall be implemented in accordance with paragraph (g) of this section to protect employees from exposure to hazardous substances and health hazards.

(7) **Monitoring.** Monitoring shall be performed in accordance with paragraph (h) of this section to assure proper selection of engineering controls, work practices and personal protective equipment so that employees are not exposed to levels which exceed established permissible exposure limits for hazardous substances.

(8) **Informational program.** Employees, contractors, and subcontractors or their representative shall be informed of the degree and nature of safety and health hazards specific to the work site by using the safety and health plan outlined in paragraph (i) of this section.

(9) **Material handling.** Hazardous substances and contaminated soils, liquids, and other residues shall be handled, transported, labeled, and disposed of in accordance with paragraph (j) of this section.

(10) **Decontamination.** Procedures for all phases of decontamination shall be developed and implemented in accordance with paragraph (k) of this section.

(11) **Emergency response.** Emergency response to hazardous waste operation incidents shall be conducted in accordance with paragraph (l) of this section.

(12) **Illumination.** Areas accessible to employees shall be lighted in accordance with the requirements of paragraph (m) of this section.

(13) **Sanitation.** Facilities for employee sanitation shall be provided in accordance with paragraph (n) of this section.

(14) **Site excavation.** Site excavations created during initial site preparation or during hazardous waste operations shall be shored or sloped to prevent accidental collapse and conducted in accordance with Subpart P of 29 CFR Part 1926.

(15) **Contractors and sub-contractors.** An employer who retains contractor or

(4) Trainers shall have received a level of training higher than and including the subject matter of the level of instruction that they are providing.

(5) Employees shall not participate in field activities until they have been trained to a level required by their job function and responsibility.

(6) Employees and supervisors that have received and successfully completed the training and field experience specified in paragraphs (e)(1), (e)(2) and (e)(3) of this section shall be certified by their instructor as having completed the necessary training. Any person who has not been so certified or meets the requirements of paragraph (e)(1) of this section shall be prohibited from engaging in hazardous waste operations after March 16, 1987.

(7) Employees who are responsible for responding to hazardous emergency situations that may expose them to hazardous substances shall be trained in how to respond to expected emergencies.

(8) Employees specified in paragraph (e)(1) and managers specified in paragraph (e)(3) of this section shall receive eight hours of refresher training annually on the items specified in paragraph (e)(1) of this section and other relevant topics.

(9) Employers who can show by an employee's work experience and/or training that the employee has had initial training equivalent to that training required in paragraphs (e)(1), (e)(2), and (e)(3) of this section shall be considered as meeting the initial training requirements of those paragraphs. Equivalent training includes the training that existing employees might have already received from actual, on-site experience.

(f) *Medical surveillance*—(1) *Employees covered.* A medical surveillance program shall be instituted by the employer for:

(i) all employees who are or may be exposed to hazardous substances or health hazards at or above the established permissible exposure limits for these substances, without regard to the use of respirators, for 30 days or more a year, or

(ii) all employees who wear a respirator for 30 days or more a year, or

(iii) HAZMAT employees specified in paragraph (1)(4) of this section while engaged in hazardous waste operations covered by this section.

(iv) The employer shall make medical examinations or consultations available to all employees who may have been exposed in an emergency situation to hazardous substances at concentrations above the permissible exposure limits.

(2) *Frequency of medical examinations and consultations.*

Medical examinations and consultations shall also be made available by the employer to each employee covered under paragraph (f)(1) of this section on the following schedules:

(i) Prior to assignment or for employees covered on the effective date of this standard as specified in paragraph (p) of this section.

(ii) At least once every twelve months for each employee covered.

(iii) At termination of employment or reassignment to an area where the employee would not be covered if the employee has not had an examination within the last six months.

(iv) As soon as possible, upon notification by an employee either that the employee has developed signs or symptoms indicating possible overexposure to hazardous substances or health hazards

(v) At more frequent times, if the examining physician determines that an increased frequency of examination is medically necessary.

(3) *Content of medical examinations and consultations.* (i) Medical examinations required by paragraph (f)(2) of this section shall include a medical and work history with special emphasis on symptoms related to the handling of hazardous substances and to fitness for duty including the ability to wear any required PPE under conditions (i.e., temperature extremes) that may be expected at the work site.

(ii) The content of medical examinations or consultations made available to employees pursuant to paragraph (f) shall be determined by the examining physician.

(4) *Examination by a physician and costs.* All medical examinations and procedures shall be performed by or under the supervision of a licensed physician, and shall be provided without cost to the employee, without loss of pay, and at a reasonable time and place.

(5) *Information provided to the physician.* The employer shall provide the following information to the examining physician:

(i) A copy of this standard and its appendices.

(ii) A description of the employee's duties as they relate to the employee's exposures.

(iii) The employee's exposure levels or anticipated exposure levels.

(iv) A description of any personal protective equipment used or to be used, and

(v) Information from previous medical examinations of the employee which is not readily available to the examining physician.

(6) *Physician's written opinion.* (i) The employer shall obtain and furnish the employee with a copy of a written opinion from the examining physician containing the following:

(A) The results of the medical examination and tests.

(B) The physician's opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health.

(C) The physician's recommended limitations upon the employees assigned work.

(D) A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further examination or treatment.

(ii) The written opinion obtained by the employer shall not reveal specific findings or diagnoses unrelated to occupational exposure.

(7) *Recordkeeping.* (i) An accurate record of the medical surveillance required by paragraph (f)(1) of this section shall be retained. This record shall be retained for the period specified and meet the criteria of 29 CFR 1910.20.

(ii) The record required in paragraph (f)(5)(i) of this section shall include at least the following information:

(A) The name and social security number of the employee;

(B) Physicians' written opinions;

(C) Any employee medical complaints related to exposure to hazardous substances;

(D) A copy of the information which shall be provided to the examining physician by the employer, with the exception of the standard and its appendices.

(iii) The employer shall ensure that this record is retained for the period specified in 29 CFR 1910.20.

(g) *Engineering controls, work practices, and personal protective equipment for employee protection*—(1) *Engineering controls, work practices and PPE.* (i) Engineering controls and work practices shall be instituted to reduce and maintain employee exposure to or below the permissible exposure limits of those hazardous substances regulated by 29 CFR Part 1910, Subpart Z, except to the extent that such controls and practices are not feasible.

*Note.*—Engineering controls which may be feasible are the use of pressurized cabs or control booths on equipment, and/or the use of remotely operated material handling equipment. Work practices which may be feasible are removing all nonessential employees from potential exposure during opening of drums, wetting down dusty

appropriate DOT, OSHA, and EPA regulations for the wastes that they contain.

(ii) Drums and containers shall be inspected and their integrity shall be assured prior to being moved. Drums or containers that cannot be inspected before being moved because of inaccessible storage conditions shall be moved to an accessible location and inspected prior to further handling.

(iii) Unlabeled drums and containers shall be considered to contain hazardous substances and handled accordingly until the contents are positively identified and labeled.

(iv) Site operations shall be organized to minimize the amount of drum or container movement.

(v) Prior to movement of drums or containers, all employees exposed to the transfer operation shall be warned of the potential hazards associated with the contents of the drums or containers.

(vi) U.S. Department of Transportation specified salvage drums or containers and suitable quantities of proper absorbent shall be kept available and used in areas where spills, leaks, or ruptures may occur.

(vii) Where major spills may occur, a spill containment program shall be implemented to contain and isolate the entire volume of the hazardous substance being transferred.

(viii) Drums and containers that cannot be moved without rupture, leakage, or spillage shall be emptied into a sound container using a device classified for the material being transferred.

(ix) A ground-penetrating system or other type of detection system or device shall be used to estimate the location and depth of drums or containers.

(x) Soil or covering material shall be removed with caution to prevent drum or container rupture.

(xi) Fire extinguishing equipment meeting the requirements of 29 CFR Part 1910, Subpart L shall be on hand and ready for use to control small fires.

**(2) Opening drums and containers.**

The following procedures shall be followed in areas where drums or containers are being opened:

(i) Where an airline respirator system is used, connections to the bank of air cylinders shall be protected from contamination and the entire system shall be protected from physical damage.

(ii) Employees not actually involved in opening drums or containers shall be kept a safe distance from the drums or containers being opened.

(iii) If employees must work near or adjacent to drums or containers being opened, a suitable shield that does not

interfere with the work operation shall be placed between the employee and the drums or containers being opened to protect the employee in case of accidental explosion.

(iv) Controls for drum or container opening equipment, monitoring equipment, and fire suppression equipment shall be located behind the explosion-resistant barrier.

(v) Material handling equipment and hand tools shall be of the type to prevent sources of ignition.

(vi) Drums and containers shall be opened in such a manner that excess interior pressure will be safely relieved. If pressure cannot be relieved from a remote location, appropriate shielding shall be placed between the employee and the drums or containers to reduce the risk of employee injury.

(vii) Employees shall not stand upon or work from drums or containers.

**(3) Electrical material handling equipment.** Electrical material handling equipment used to transfer drums and containers shall:

(i) Be positioned and operated to minimize sources of ignition related to the equipment from igniting vapors released from ruptured drums or containers, or

(ii) Meet the requirements of 29 CFR 1910.307 and be of the appropriate electrical classification for the materials being handled.

**(4) Radioactive wastes.** Drums and containers containing radioactive wastes shall not be handled until such time as their hazard to employees is properly assessed.

**(5) Shock sensitive wastes.**

Caution: Shipping of shock sensitive wastes may be prohibited under U.S. Department of Transportation regulations. Employers and their shippers should refer to 49 CFR 173.21 and 173.50.

As a minimum, the following special precautions shall be taken when drums and containers containing or suspected of containing shock-sensitive wastes are handled:

(i) All non-essential employees shall be evacuated from the area of transfer.

(ii) Material handling equipment shall be provided with explosive containment devices or protective shields to protect equipment operators from exploding containers.

(iii) An employee alarm system capable of being perceived above surrounding light and noise conditions shall be used to signal the commencement and completion of explosive waste handling activities.

(iv) Continuous communications (i.e., portable radios, hand signals, telephones, as appropriate) shall be

maintained between the employee-in-charge of the immediate handling area and the site safety officer or command post until such time as the handling operation is completed. Communication equipment or methods that could cause shock sensitive materials to explode shall not be used.

(v) Drums and containers under pressure, as evidenced by bulging or swelling, shall not be moved until such time as the cause for excess pressure is determined and appropriate containment procedures have been implemented to protect employees from explosive relief of the drum.

(vi) Drums and containers containing packaged laboratory wastes shall be considered to contain shock-sensitive or explosive materials until they have been characterized.

**(6) Laboratory waste packs.** In addition to the requirements of paragraph (j)(5) of this section, the following precautions shall be taken, as a minimum, in handling laboratory waste packs (lab packs):

(i) Lab packs shall be opened only when necessary and then only by an individual knowledgeable in the inspection, classification, and segregation of the containers within the pack according to the hazards of the wastes.

(ii) If crystalline material is noted on any container, the contents shall be handled as a shock-sensitive waste until the contents are identified.

**(7) Sampling drums and containers.** Sampling of containers and drums shall be done in accordance with a sampling procedure which is part of the site safety and health plan developed for and available to employees and others at the specific worksite.

**(8) Shipping and transport.** (i) Drums and containers shall be identified and classified prior to packaging for shipment.

(ii) Drum or container staging areas shall be kept to the minimum number necessary to safely identify and classify materials and prepare them for transport.

(iii) Staging areas shall be provided with adequate access and egress routes.

(iv) Bulking of hazardous wastes shall be permitted only after a thorough characterization of the materials has been completed.

**(9) Tank and vault procedures.** (i) Tanks and vaults containing hazardous substances shall be handled in a manner similar to that for drums and containers, taking into consideration the size of the tank or vault.

(ii) Appropriate tank or vault entry procedures meeting paragraph

provide assistance or rescue. Qualified basic life support personnel, as a minimum, shall also be standing by with medical equipment and transportation capability.

(C) The individual in charge of the ICS shall designate a safety officer, who is knowledgeable in fire fighting or rescue operations and hazardous substance handling procedures, with specific responsibility to identify and evaluate hazards and to provide direction with respect to the safety of operations for the emergency at hand.

(H) When activities are judged by the safety officer to be unsafe and/or to involve an imminent danger condition, the safety officer shall have the authority to alter, suspend, or terminate those activities. The safety officer shall immediately inform the individual in charge of the ICS of any actions taken to correct these hazards at an emergency scene.

(I) After emergency operations have terminated, the individual in charge of the ICS shall implement appropriate decontamination procedures.

(4) **Hazardous materials teams (HAZMAT).** (i) Employees who are members of the HAZMAT team, employees designated by the employer to plug, patch or otherwise temporarily control or stop leaks from containers which hold hazardous substances or health hazards shall be given training in accordance with paragraph (l)(3) of this section that includes the care and use of chemical protective clothing and procedures to be followed when working on leaking drums, containers, tanks, or bulk transport vehicles.

(ii) Members of HAZMAT teams shall receive an annual physical examination by a licensed physician and be provided medical surveillance as required in paragraph (f) of this section.

(iii) Personal protective clothing and equipment to be used by HAZMAT team members shall meet the requirements of paragraph (g) of this section.

(iv) Approved self-contained compressed air breathing apparatus may be used with approved cylinders from other approved self-contained compressed air breathing apparatus provided that such cylinders are of the same capacity and pressure rating. All compressed air cylinders used with self-contained breathing apparatus shall meet U.S. Department of Transportation and National Institute for Occupational Safety and Health criteria.

(5) **Post-emergency response operations.** Upon completion of the emergency response, if it is determined that it is necessary to remove hazardous substances, health hazards and materials contaminated with them such

as contaminated soil or other elements of the natural environment, then such operations shall meet all the requirements of paragraphs (b) through (n) of this section.

(m) **Illumination.** Work areas shall be lighted to not less than the minimum illumination intensities listed in Table H-102.1 while any work is in progress:

TABLE H-102.1.—MINIMUM ILLUMINATION INTENSITIES IN FOOT-CANDLES

Foot-candles	Area or operations
5	General site areas.
5	Excavation and waste areas, accessways, active storage areas, loading platforms, refueling, and field maintenance areas.
5	Indoors: warehouses, corridors, hallways, and entryways.
5	Tunnels, shafts, and general underground work areas; (Exception: minimum of 10 foot-candles is required at tunnel and shaft heading during drilling, mucking, and scaling. Bureau of Mines approved cap lights shall be acceptable for use in the tunnel heading.)
10	General shops (e.g., mechanical and electrical equipment rooms, active storerooms, barracks or living quarters, locker or dressing rooms, dining areas, and indoor toilets and workrooms).
30	First aid stations, infirmaries, and offices.

(n) **Sanitation at temporary workplaces—(1) Potable water.** (i) An adequate supply of potable water shall be provided on the site.

(ii) Portable containers used to dispense drinking water shall be capable of being tightly closed, and equipped with a tap. Water shall not be dipped from containers.

(iii) Any container used to distribute drinking water shall be clearly marked as to the nature of its contents and not used for any other purpose.

(iv) Where single service cups (to be used but once) are supplied, both a sanitary container for the unused cups and a receptacle for disposing of the used cups shall be provided.

(2) **Nonpotable water.** (i) Outlets for nonpotable water, such as water for industrial or firefighting purposes shall be identified to indicate clearly that the water is unsafe and is not to be used for drinking, washing, or cooking purposes.

(ii) There shall be no cross-connection, open or potential, between a system furnishing potable water and a system furnishing nonpotable water.

(3) **Toilets facilities.** (i) Toilets shall be provided for employees according to Table H-102.2.

TABLE H-102.2.—TOILET FACILITIES

Number of employees	Minimum number of facilities
20 or fewer	One.
More than 20, fewer than 200.	One toilet seat and 1 urinal per 40 employees.

TABLE H-102.2.—TOILET FACILITIES—Continued

Number of employees	Minimum number of facilities
More than 200	One toilet seat and 1 urinal per 50 employees.

(ii) Under temporary field conditions, provisions shall be made to assure not less than one toilet facility is available.

(iii) Hazardous waste sites, not provided with a sanitary sewer, shall be provided with the following toilet facilities unless prohibited by local codes:

- (A) Privies;
- (B) Chemical toilets;
- (C) Recirculating toilets; or
- (D) Combustion toilets.

(iv) The requirements of this paragraph for sanitation facilities shall not apply to mobile crews having transportation readily available to nearby toilet facilities.

(4) **Food handling.** All employees' food service facilities and operations shall meet the applicable laws, ordinances, and regulations of the jurisdictions in which they are located.

(5) **Temporary sleeping quarters.** When temporary sleeping quarters are provided, they shall be heated, ventilated, and lighted.

(6) **Washing facilities.** The employer shall provide adequate washing facilities for employees engaged in operations where hazardous substances may be harmful to employees. Such facilities shall be in near proximity to the worksite, within controlled access work zones and shall be so equipped as to enable employees to remove hazardous substances.

(c) **Certain Operations Conducted under the Resource Conservation and Recovery Act of 1976 (RCRA).** Employers conducting operations specified in paragraph (g)(2)(iii) of this section shall:

(1) Implement a hazard communication program meeting the requirements of 29 CFR 1910.1200;

(2) Implement a medical surveillance program meeting the requirements of paragraph (f) of this section;

(3) Develop and implement a safety and health program for employees involved in hazardous waste operations. The program shall be designed to identify, evaluate and control safety and health hazards and provide for emergency response to their facilities for the purpose of employee protection;

(4) Develop and implement a decontamination procedure in accordance with paragraph (k) of this section, and



seams, closures, lens gaskets, glove-to-sleeve joints, etc.) with a mild soap and water solution. Observe the suit for the formation of soap bubbles, which is an indication of a leak. Repair all identified leaks.

7.2 Retest the TECP suit as outlined in Test procedure 6.0.

#### —Report

8.1 Each TECP suit tested by this practice shall have the following information recorded.

8.1.1 Unique identification number identifying brand name, date of purchase, material of construction, and unique fit features; e.g., special breathing apparatus.

8.1.2 The actual values for test pressures, A, B, and C shall be recorded along with the specific observation times. If the ending pressure (C) is less than 80% of the test pressure (B) the suit shall be identified as failing the test. When possible, the specific leak location shall be identified in the test records. Retest pressure data shall be recorded as an additional test.

8.1.3 The source of the test apparatus used shall be identified and the sensitivity of the pressure gauge shall be recorded.

8.1.4 Records shall be kept for each pressure test even if repairs are being made at the test location.

#### Caution

Visually inspect all parts of the suit to be sure they are positioned correctly and secured tightly before putting the suit back into service. Special care should be taken to examine each exhaust valve to make sure it is not blocked.

Care should also be exercised to assure that the inside and outside of the suit is completely dry before it is put into storage.

#### B. Fully-Encapsulated Suit Qualitative Leak Test

##### 1.0—Scope

1.1 This practice semi-qualitatively tests gas tight totally-encapsulating chemical protective suit integrity by detecting inward leakage of ammonia vapor. Since no modifications are made to the suit to carry out this test, the results from this practice provide a realistic test for the integrity of the entire suit.

1.2 Resistance of the suit materials to permeation, penetration, and degradation is not determined by this test method.

##### 2.0—Description of Terms

2.1 Totally-encapsulated chemical protective suit (TECP suit)—A full body garment which is constructed of protective clothing materials; covers the wearer's torso, head, arms, and legs; may cover the wearer's hands and feet with tightly attached gloves and boots; completely encloses the wearer by itself or in combination with the wearer's respiratory equipment, gloves, and boots.

2.2 Protective clothing material—Any material or combination of materials used in an item of clothing for the purpose of isolating parts of the body from direct contact with a potentially hazardous liquid or gaseous chemicals.

2.3 "Gas tight"—for the purpose of this practice the limited flow of a gas under pressure from the inside of a TECP suit to

atmosphere at a prescribed pressure and time interval.

2.4 "Shall"—This term indicates a mandatory requirement.

2.5 "Should"—This term indicates a recommendation or that which is advised but not required.

2.6 "May"—This term is used to state a permissive use or an alternative method to a specific requirement.

2.7 Intrusion Coefficient—A number expressing the level of protection provided by a gas tight totally-encapsulating chemical protective suit. The intrusion coefficient is calculated by dividing the test room challenge agent concentration by the concentration of challenge agent found inside the suit. The accuracy of the intrusion coefficient is dependent on the challenge agent monitoring methods. The larger the intrusion coefficient the greater the protection provided by the TECP suit.

##### 3.0—Summary of Recommended Practice

3.1 The volume of ammonia solution required to generate the test atmosphere is determined using the directions outlined in 6.1. The suit is donned by a person wearing the appropriate respiratory equipment (normally a self-contained breathing apparatus) and worn inside the enclosed test room. The ammonia solution is taken by the suited individual into the test room and poured into an open plastic pan. A two-minute evaporation period is observed before the test room concentration is measured using a high range ammonia length of stain detector tube. When the ammonia reaches a concentration of between 1000 and 1200 ppm, the suited individual starts a standardized exercise protocol to stress and flex the suit. After this protocol is completed the test room concentration is measured again. The suited individual exits the test room and his stand-by person measures the ammonia concentration inside the suit using a low range ammonia length of stain detector tube or other more sensitive ammonia detector. A stand-by person is required to observe the test individual during the test procedure, aid the person in donning and doffing the TECP suit and monitor the suit interior. The intrusion coefficient of the suit can be calculated by dividing the average test area concentration by the interior suit concentration. A colorimetric indicator strip of bromophenol blue is placed on the inside of the suit face piece lens so that the suited individual is able to detect a color change and know if the suit has a significant leak. If a color change is observed the individual should leave the test room immediately.

##### 4.0—Required Supplies

4.1 A supply of concentrated ammonia (58 percent ammonium hydroxide by weight).

4.2 A supply of bromophenol/blue indicating paper, sensitive to 5–10 ppm ammonia or greater over a two-minute period of exposure.

4.3 A supply of high range (0.5–10 volume percent) and low range (5–700 ppm) detector tubes for ammonia and the corresponding sampling pump. More sensitive ammonia detectors can be substituted for the low range detector tubes to improve the sensitivity of this practice.

4.4 A plastic pan (PVC) at least 12" x 14" x 1" and a half pint plastic container ("C") with tightly closing lid.

4.5 Volumetric measuring device of at least 50 milliliters in volume with an accuracy of at least  $\pm 1$  milliliters.

##### 5.0—Safety Precautions

5.1 Concentrated ammonia is a corrosive volatile liquid requiring eye, skin, and respiratory protection.

5.2 Since the threshold limit value for ammonia is 25 ppm, only persons wearing the appropriate respirator protection shall be in the chamber. Normally only the person wearing the total-encapsulating suit will be inside the chamber. A stand-by person shall have a self-contained breathing apparatus, or equivalent breathing apparatus, available to enter the test area should the suited individual need assistance.

5.3 A method to monitor the suited individual must be used during this test. Visual contact is the simplest but other methods using communication devices are acceptable.

5.4 The test room shall be large enough to allow the exercise protocol to be carried out and ventilated to allow for easy exhaust of the ammonia test atmosphere after the test(s) are completed.

5.5 Individuals shall be medically screened for the use of respiratory protection and checked for allergies to ammonia before participating in this test procedure.

##### 6.0—Test Procedure

6.1.1 Measure the test area to the nearest foot and calculate its volume in cubic feet. Multiply the test area volume by 0.2 milliliters of ammonia per cubic foot of test area volume to determine the approximate volume of ammonia required to generate 100 ppm in the test area.

6.1.2 Measure this volume from the supply of concentrated ammonia and place it into a closed plastic container.

6.1.3 Place the jar, several high range ammonia detector tubes and the pump in the clean test pan and locate it near the test area entry door so that the suited individual has easy access to these supplies.

6.2.1 In a non-contaminated atmosphere, open a presealed ammonia indicator strip and fasten one end of the strip to the inside of suit face shield lens where it can be seen by the wearer. Care shall be taken not to contaminate the detector part of the indicator paper by touching it. A small piece of masking tape or equivalent should be used to attach the indicator strip to the interior of the suit face shield.

6.2.2 If problems are encountered with this method of attachment the indicator strip can be attached to the outside of the respirator face piece being used during the test, assuming the face piece is worn within the TECP suit.

6.3 Don the respiratory protective device normally used with the suit; and then don the TECP suit to be tested. Check to be sure all openings which are intended to be sealed (zippers, gloves, etc.) are completely sealed. DO NOT, however, plug off any venting valves.

**II. Level B**—The highest level of respiratory protection is necessary but a lesser level of skin protection is needed.

Level B equipment; used as appropriate

1. Pressure-demand, full-facepiece self-contained breathing apparatus (SCBA), or pressure-demand supplied air respirator with escape SCBA (NIOSH approved).
2. Hooded chemical-resistant clothing (overall and long-sleeved jacket; coveralls; one or two-piece chemical-splash suit; disposable chemical-resistant overalls).
3. Coveralls\*.
4. Gloves, outer, chemical-resistant.
5. Gloves, inner, chemical-resistant.
6. Boots, outer, chemical-resistant steel toe and shank.
7. Boot-covers, outer, chemical-resistant (disposable)\*.
8. Hard hat.
9. Two-way radios (worn inside encapsulating suit).
10. Face shield.\*
- \*Optional, as applicable.

**III. Level C**—The concentration(s) and type(s) of airborne substance(s) is known and the criteria for using air purifying respirators are met.

Level C equipment; used as appropriate

1. Full-face or half-mask, air purifying, canister-equipped respirators (NIOSH approved).
2. Hooded chemical-resistant clothing (overall; two-piece chemical-splash suit; disposable chemical-resistant overalls).
3. Coveralls\*.
4. Gloves, outer, chemical-resistant.
5. Gloves, inner, chemical-resistant.
6. Boots (outer), chemical-resistant steel toe and shank\*.
7. Boot-covers, outer, chemical-resistant (disposable)\*.
8. Hard hat.
9. Escape mask\*.
10. Two-way radios (worn under outside protective clothing).
11. Face shield\*.
- \*Optional, as applicable.

**IV. Level D**—A work uniform affording minimal protection; used for nuisance contamination only.

Level D equipment; used as appropriate

1. Coveralls.
2. Gloves\*.
3. Boots/shoes, chemical-resistant steel toe and shank.
4. Boots, outer, chemical-resistant (disposable)\*.
5. Safety glasses or chemical splash goggles\*.
6. Hard hat.
7. Escape mask\*.
8. Face shield\*.
- \*Optional, as applicable.

**Part B.** The types of hazards for which levels A, B, C, and D protection are appropriate are described below:

**1. Level A**—Level A protection should be used when:

1. The hazardous substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on either the measured (or potential for) high concentration of

atmospheric vapors, gases, or particulates; or the site operations and work functions involve a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to skin or capable of being absorbed through the intact skin.

2. Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible, or

3. Operations must be conducted in confined, poorly ventilated areas and the absence of conditions requiring Level A have not yet been determined.

**II. Level B** protection should be used when:

1. The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection.

**Note.**—This involves atmospheres with IDLH concentrations of specific substances that do not represent a severe skin hazard; or that do not meet the criteria for use of air-purifying respirators.

2. The atmosphere contains less than 19.5 percent oxygen, or

3. The presence of incompletely identified vapors or gases is indicated by a direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the intact skin.

**III. Level C** protection should be used when:

1. The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect or be absorbed through any exposed skin.

2. The types of air contaminants have been identified, concentrations measured, and a canister respirator is available that can remove the contaminants, and

3. All criteria for the use of air-purifying respirators are met.

**IV. Level D** protection should be used when:

1. The atmosphere contains no known hazard, and

2. Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

**Note.**—As stated before combinations of personal protective equipment other than those described for Levels A, B, C, and D protection may be more appropriate and may be used to provide the proper level of protection.

#### Appendix C—Compliance Guidelines

**1. Occupational Safety and Health Program.** Each hazardous waste site clean-up effort will require a site specific occupational safety and health program headed by the site coordinator or the employer's representative. The program will be designed for the protection of employees at the site. The program will need to be developed before work begins on the site and implemented as work proceeds. The program is to facilitate coordination and communication among personnel responsible for the various activities which will take place at the site. It will provide the overall means for planning and implementing the needed safety and

health training and job orientation of employees, who will be working at the site. The program will provide the means for identifying and controlling worksite hazards and the means for monitoring program effectiveness. The program will need to cover the responsibilities and authority of the site coordinator for the safety and health of employees at the site, and the relationships with contractors or support services as to what each employer's safety and health responsibilities are for their employees on the site. Each contractor on the site needs to have its own safety and health program so structured that it will smoothly interface with the program of the site coordinator.

Each site safety and health program will need to include the following: (1) Policy statements of the line of authority and accountability for implementing the program, the objectives of the program and the role of the site safety and health officer or manager and staff; (2) means or methods for the development of procedures for identifying and controlling workplace hazards at the site; (3) means or methods for the development and communication to employees of the various plans, work rules, standard operating procedures and practices that pertain to individual employees and supervisors; (4) the training of supervisors and employees to develop the needed skills and knowledge to perform their work in a safe and healthful manner; (5) means to anticipate and prepare for emergency situations and; (6) information feedback to aid in evaluating the program and for improving the effectiveness of the program. The management and employees should be trying continually to improve the effectiveness of the program thereby enhancing the protection being afforded those working on the site.

Accidents on the site should be investigated to provide information on how such occurrences can be avoided in the future. When injuries or illnesses occur on the site, they will need to be investigated to determine what needs to be done to prevent this incident from occurring again. Such information will need to be used as feedback on the effectiveness of the program and the information turned into positive steps to prevent any reoccurrence. Receipt of employee suggestions or complaints relating to safety and health issues involved with site activities is also a feedback mechanism that needs to be used effectively to improve the program and may serve in part as an evaluative tool(s).

**2. Training.** The employer is encouraged to utilize those training programs that have been recognized by the National Institute of Environmental Health Sciences through its training grants program. These training and educational programs are being developed for the employees who work directly with hazardous substances. For further information about these programs contact: National Institute of Environmental Health Sciences, P.O. Box 12233, Research Triangle Park, NC 27709

Training programs for emergency service organizations are available from the U.S. National Fire Academy, Emmitsburg, MD and the various state fire training schools. The

# **Appendix M**

## **Heat / Cold Stress Monitoring**

**ADOPTED THRESHOLD LIMIT VALUES (TLVs)  
FOR HEAT STRESS**

**FROM: *Threshold Limit Values for Physical Agents  
in the Work Environment Adopted by ACGIH  
with Intended Changes 1985 - 1986***

**American Conference of Governmental Industrial Hygienists**



# **ADOPTED THRESHOLD LIMIT VALUES HEAT STRESS**

These Threshold Limit Values (TLVs) refer to heat stress conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse health effects. The TLVs shown in Table 1 are based on the assumption that nearly all acclimatized, fully clothed workers with adequate water and salt intake should be able to function effectively under the given working conditions without exceeding a deep body temperature of 38°C.<sup>(1,2)</sup>

Since measurement of deep body temperature is impractical for monitoring the workers' heat load, the measurement of environmental factors is required which most nearly correlates with deep body temperature and other physiological responses to heat. At the present time Wet Bulb Globe Temperature Index (WBGT) is the simplest and most suitable technique to measure the environmental factors. WBGT values are calculated by the following equations:

1. Outdoors with solar load:  
 $WBGT = 0.7 NWB + 0.2 GT + 0.1 DB$
2. Indoors or Outdoors with no solar load:  
 $WBGT = 0.7 NWB + 0.3 GT$

where:

WBGT = Wet Bulb Globe Temperature Index  
NWB = Natural Wet-Bulb Temperature  
DB = Dry-Bulb Temperature  
GT = Globe Temperature

The determination of WBGT requires the use of a black globe thermometer, a natural (static) wet-bulb thermometer, and a dry-bulb thermometer.

Higher heat exposures than shown in Table 1 are permissible if the workers have been undergoing medical surveillance and it has been established that they are more tolerant to work in heat than the average worker. Workers should not be permitted to continue their work when their deep body temperature exceeds 38.0°C.

## **Evaluation and Control**

### **1. Measurement of the Environment**

The instruments required are a dry-bulb, a natural wet-bulb, a globe thermometer, and a stand. The measurement of the environmental factors shall be performed as follows:

**TABLE 1  
Permissible Heat Exposure Threshold Limit Values  
(Values are given in °C WBGT)**

Work—Rest Regimen	Work Load		
	Light	Moderate	Heavy
Continuous work	30.0	26.7	25.0
75% Work — 25% Rest, each hour	30.6	28.0	25.9
50% Work — 50% Rest, each hour	31.4	29.4	27.9
25% Work — 75% Rest, each hour	32.2	31.1	30.0

A. The range of the dry and the natural wet bulb thermometer shall be -5°C to 50°C with an accuracy of  $\pm 0.5^\circ\text{C}$ . The dry bulb thermometer must be shielded from the sun and the other radiant surfaces of the environment without restricting the airflow around the bulb. The wick of the natural wet-bulb thermometer shall be kept wet with distilled water for at least 1/2 hour before the temperature reading is made. It is not enough to immerse the other end of the wick into a reservoir of distilled water and wait until the whole wick becomes wet by capillary. The wick shall be wetted by direct application of water from a syringe 1/2 hour before each reading. The wick shall extend over the bulb of the thermometer, covering the stem about one additional bulb length. The wick should always be clean and new wicks should be washed before using.

B. A globe thermometer, consisting of a 15 cm (6-inch) diameter hollow copper sphere painted on the outside with a matte black finish or equivalent, shall be used. The bulb or sensor of a thermometer (range -5° to +100°C with an accuracy of  $\pm 0.5^\circ\text{C}$ ) must be fixed in the center of the sphere. The globe thermometer shall be exposed at least 25 minutes before it is read.

C. A stand shall be used to suspend the three thermometers so that they do not restrict free air flow around the bulbs, and the wet-bulb and globe thermometer are not shaded.

D. It is permissible to use any other type of temperature sensor that gives identical reading as that of a mercury thermometer under the same conditions.

**TABLE 3**  
**Activity Examples<sup>a</sup>**

- Light hand work: writing, hand knitting
- Heavy hand work: typewriting
- Heavy work with one arm: hammering in nails (shoemaker, upholsterer)
- Light work with two arms: filing metal, planing wood, raking of a garden
- Moderate work with the body: cleaning a floor, beating a carpet
- Heavy work with the body: railroad track laying digging, barking trees

#### Simple Calculation

Assembly line work using a heavy hand tool.

A. Walking along	2.0 kcal/min
B. Intermediate value between heavy work with two arms and light work with the body	3.0 kcal/min
	Subtotal: 5.0 kcal/min
C. Add for basal metabolism	1.0 kcal/min
	Total: 6.0 kcal/min

#### III. Work-Rest Regimen

The permissible exposure limits specified in Table 1 and Figure 1 are based on the assumption that the WBGT value of the resting place is the same or very close to that of the workplace. Where the WBGT of the work area is different from that of the rest area a time-weighted average value should be used for both environmental and metabolic heat. When time-weighted average values are used, the appropriate curve on Figure 1 is the solid line labeled "continuous."

The time-weighted average metabolic rate (M) shall be determined by the equation:

$$Av. M = \frac{M_1 \times t_1 + M_2 \times t_2 + \dots + M_n \times t_n}{t_1 + t_2 + \dots + t_n}$$

where  $M_1$ ,  $M_2$ ,...and  $M_n$  are estimated or measured metabolic rates for the various activities and rest periods of the worker during the time periods  $t_1$ ,  $t_2$ ,...and  $t_n$  (in minutes) as determined by a time study.

The time-weighted average WBGT shall be determined by the equation:

$$Av. WBGT = \frac{WBGT_1 \times t_1 + WBGT_2 \times t_2 + \dots + WBGT_n \times t_n}{t_1 + t_2 + \dots + t_n}$$

where  $WBGT_1$ ,  $WBGT_2$ ,... and  $WBGT_n$  are calculated values of WBGT for the various work and rest occupied during total time periods  $t_1$ ,  $t_2$ ,... and  $t_n$  are the elapsed times in minutes spent in the corresponding areas which are determined by a time study. Where exposure to hot environmental conditions is continuous for several hours or the entire work day, the time-weighted averages shall be calculated as hourly time-weighted average, i.e.,  $t_1 + t_2 + \dots + t_n = 60$  minutes. Where the exposure is intermittent, the time-weighted averages shall be calculated as two-hour time-weighted averages, i.e.,  $t_1 + t_2 + \dots + t_n = 120$  minutes.

The permissible exposure limits for continuous work are applicable where there is a work-rest regimen of a 5-day work week and an 8-hour work day with a short morning and afternoon break (approximately 15 minutes) and a longer lunch break (approximately 30 minutes). Higher exposure limits are permitted if additional resting time is allowed. All breaks, including unscheduled pauses and administrative or operational waiting periods during work, may be counted as rest time when additional rest allowance must be given because of high environmental temperatures.

#### IV. Water and Salt Supplementation

During the hot season or when the worker is exposed to artificially generated heat, drinking water shall be made available to the workers in such a way that they are stimulated to frequently drink small amounts, i.e., one cup every 15-20 minutes (about 150 ml or 1/4 pint).

The water shall be kept reasonably cool (10°-15°C or 50.0°-60.0°F) and shall be placed close to the workplace so that the worker can reach it without abandoning the work area.

The workers should be encouraged to salt their food abundantly during the hot season and particularly during hot spells. If the workers are unacclimatized, salted drinking water shall be made available in a concentration of 0.1% (1 g NaCl to 1.0 liter or 1 level tablespoon of salt to 15 quarts of water). The added salt shall be completely dissolved before the water is distributed, and the water shall be kept reasonably cool.

#### V. Other Considerations

A. Clothing: The permissible heat exposure TLVs are valid for light summer clothing as customarily worn by workers when working

**NIOSH RECOMMENDED STANDARD FOR  
OCCUPATIONAL EXPOSURE TO HOT ENVIRONMENTS**

U.S. Department of Health, Education, and Welfare  
Public Health Service  
Center for Disease Control  
National Institute for Occupational Safety and Health

## I. RECOMMENDATIONS FOR A STANDARD FOR WORK IN HOT ENVIRONMENTS

The National Institute for Occupational Safety and Health (NIOSH) recommends that employee exposure to heat in the workplace be controlled by requiring compliance with the work practice standard set forth in the following sections. Adherence to the precautionary procedures prescribed will prevent acute or chronic heat disorders and illnesses and heat induced unsafe acts, and will reduce the risk of harmful effects due to the interactions between excessive heat and toxic chemicals and physical agents. The standard is amenable to techniques that are valid, reproducible, and presently available. It will be reviewed and revised as necessary.

### Section 1 — Definitions

(a) Acclimatization to heat means a series of physiological and psychological adjustments that occur in an individual during his first week of exposure to a hot environment so that thereafter the individual is capable of working in a hot environment without excessive strain.

(b) Unimpaired mental performance means the ability of an employee to cope with conditions where safety and health depend on constant alertness because he has to make critical decisions, fine discriminations, or fast and skillful actions.

(c) Intermittent heat exposure means exposure to hot environmental conditions which continues no longer than fifteen minutes without an interrupting interval spent either spontaneously or according to a prescribed schedule in a cooler environment.

(d) Continuous heat exposure means any exposure to hot environmental conditions which is not an intermittent exposure.

(e) Hot environmental condition means any combination of air temperature, humidity, radiation and wind speed that exceeds a Wet Bulb Globe Temperature (WBGT) of 79°F.

### Section 2 — Applicability

The provisions of this standard are applicable to all places of employment, indoors and outdoors, and to all employees except those who are required to wear impermeable protective clothing.

### Section 3 — Work Practices

(a) For sedentary jobs where continuous unimpaired mental performance is required, no employee shall be exposed to conditions which exceed the limits set forth in Figure I-1.

(b) No employee should be permitted to work without protective observation at high heat stress levels.

(c) When exposure of an employee is continuous for one hour or intermittent for a period of two hours and the time-weighted average WBGT exceeds 79°F for men or 76°F for women, then any one or combination of the following practices shall be initiated to insure that the employee's body core temperature does not exceed 100.4°F:

#### (i) Acclimatization

(1) Unacclimatized employees shall be acclimatized over a period of 6 days. The acclimatization schedule shall begin with 50 percent of the anticipated total work load and time exposure on the first day, followed by daily 10 percent increments building up 100 percent total exposure on the sixth day.

(2) Regular acclimatized employees who return from nine or more consecutive calendar days of leave, shall undergo a four day acclimatization period. The acclimatization schedule shall begin with 50 percent of the anticipated total exposure on the first day, followed by daily 20 percent increments building up to 100 percent total exposure on the fourth day.

(3) Regular acclimatized employees who return from four consecutive days of illness should have medical permission to return to the job, and should undergo a four day re-acclimatization period as defined in (2) above.

(ii) A work and rest regimen shall be implemented to reduce the peaks of physiological strain and to improve recovery during rest periods.

(iii) The total work load shall be evenly distributed over the entire work day when possible.

(iv) When possible hot jobs shall be scheduled for the coolest part of the work shift.

(v) Regular breaks, consisting as a minimum of one every hour, shall be prescribed for employees to get water and replacement salt. The employer shall provide a minimum of 8 quarts of cool potable 0.1 percent salted drinking water or a minimum of 8 quarts of cool potable water and salt tablets per man per shift. The water supply shall be located as near as possible to the position where the employee is regularly engaged in work, but never further than 200 feet\* therefrom.

(vi) Appropriate protective clothing and equipment shall be provided and used.

(vii) Engineering controls to reduce the environmental heat load shall be utilized.

\* Except where a variance had been granted.

where  $WBGT_1$ ,  $WBGT_2$ ,  $WBGT_n$  are calculated values of WBGT for the various work and rest areas occupied during total time period;  $t_1$ ,  $t_2$ ,  $t_n$  are the elapsed times in minutes spent in the corresponding areas which are determined by a time study.

(i) Where exposure to environmental conditions is continuous for several hours or the entire work day, the WBGT shall be calculated as an hourly time-weighted-average.

(ii) Where exposure is intermittent, the WBGT shall be calculated as a two-hour time-weighted average.

#### Section 5 — Medical

(a) All employees who are 45 years of age and older and who have not had previous occupational exposure to heat shall not be assigned to jobs where the environmental conditions equal or exceed 79°F WBGT for men and 76°F WBGT for women, until they are acclimatized.

(b) All personnel who are to be assigned to hot jobs for the first time shall be evaluated by a physician prior to assignment to assure that the individual can cope with the hot environment. In the examination special emphasis should be on the cardiovascular, renal, hepatic, endocrine, and respiratory system and the skin. The examination should also include a complete medical history of the worker with specific emphasis on previous heat-related disorders or illnesses.

(c) All employees exposed to hot environmental conditions should be given a periodic physical examination every 2 years for employees under age 45, and every year for employees 45 years of age or older, that should include all components of the preplacement examination.

(d) There shall be a person available during working hours, who shall have had first aid training in recognizing the signs and symptoms of any heat disorder or illness.

#### Section 6 — Appraisal of Employees of Hazards from Exposure to Excessive Heat

Each employee who may be exposed to environmental conditions that exceed the prescribed limits shall be given training in health and safety procedures through a program that shall include the following as a minimum:

(a) Information as to water intake for replacement purposes.

(b) Information as to salt replacement.

(c) Importance of weighing each day before and after the day's work.

(d) Instruction on how to recognize the symptoms of heat disorders and illnesses, including dehydration, exhaustion, heat syncope, heat cramps, salt deficiency exhaustion, prickly heat, and heat stroke.

(e) Information as to special caution that shall be exercised in situations where employees are exposed to toxic agents and/or other stressful physical agents which may be present in addition to and simultaneously with heat.

(f) Information concerning heat acclimatization: The information shall be kept on file and readily accessible to the worker at all places of employment where he may be exposed to excessive heat.

#### Section 7 — Warning Sign

The following warning sign shall be appropriately located at one or more places to be noticed by any one entering an area where environmental conditions are 86°F WBGT or above.

### WARNING HEAT STRESS AREA

#### Section 8 — Monitoring

(a) A WBGT profile shall be established for each work place for winter and summer seasons to serve as a guide for deciding when work practices shall be initiated to conform with the requirements of the standard. The first profile shall be established within 3 months of the effective date of this standard.

(b) After the WBGT profiles have been established, monitoring shall be conducted once during July and August of each year.

#### Section 9 — Recordkeeping

(a) The following records shall be maintained:

(i) Medical records for each employee.

(ii) Records of acclimatization as required by Section 3(c)(i).

(iii) Records of the WBGT for each work area as specified in Section 8.

(b) Records required by provisions (i) and (ii) above shall be maintained for a period of the employee's employment and for one year thereafter.

(c) Records of the WBGT as specified in (iii) above shall be maintained for a period determined by the Secretary of Labor with consultation with the Secretary of Health, Education, and Welfare.

## **SECTION 9.0 HEAT AND COLD STRESS**

### **9.1 Introduction**

Stress can contribute significantly to accidents or harm workers in other ways.

The term stress denotes the physical (gravity, mechanical force, heat, cold, pathogen, injury) and psychological (fear, anxiety, crises, joy) forces that are experienced by individuals.

The body's response to stress occurs in three stages:

- **Alarm reaction** in which the body recognizes the stressor and the pituitary-adreno-cortical system responds by increasing the heart rate and blood sugar level, decreasing digestive activity and dilating the pupils.
- **Adaptive stage** in which the body repairs effect of stimulation and the stress symptoms disappear.
- **Exhaustion stage** in which the body can no longer adapt to stress and individual may develop emotional disturbances, and cardiovascular and renal diseases.

The most common types of stress that affect REM II field personnel are heat stress and cold stress. Current thinking is that heat and cold stress may be the most serious hazard to workers at wastes sites.

### **9.2 Heat Stress**

Heat stress usually is a result of protective clothing decreasing natural body ventilation, although it may occur at any time work is being performed at elevated temperatures.

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur ranging from mild (such as fatigue, irritability, anxiety, and decreased concentration, dexterity, or movement) to fatal. Because heat stress is one of the most common and potentially serious illnesses that hazardous waste sites, regular monitoring and other preventative measures are vital.

REM II site workers must learn to recognize and treat the various forms of heat stress.

The best approach is preventative heat stress management. In general:

- **Have workers drink 16 ounces of water before beginning work**, such as in the morning or after lunch. Provide disposable, 4 ounce cups, and water that is maintained at 50 - 60°F. Urge workers to drink 1 - 2 of these cups water every 20-minutes, for a total of 1 -2 gallons per day. Provide a cool, preferably air conditioned area for rest breaks. Discourage the use of alcohol in non-working hours, and discourage the intake of coffee during working hours. Monitor for signs of heat stress.
- **Acclimate workers to site work conditions by slowly increasing workloads**, ie., do not begin site work activities with extremely demanding activities.

clothing, place in a head-low position, and provide bed rest. Consult physician, especially in severe cases. The normal thirst mechanism is not sensitive enough to ensure body fluid replacement. Have patient drink 1 - 2 cups water immediately, and every 20-minutes thereafter, until symptoms subside. Total water consumption should be about 1 - 2 gallons per day.

### 9.5 Heat Cramps

Heat cramps are caused by perspiration that is not balanced by adequate fluid intake. Heat cramps are often the first sign of a condition that can lead to heat stroke.

- **Symptoms:** Acute painful spasms of voluntary muscles; e.g., abdomen and extremities.
- **Treatment:** Remove victim to a cool area and loosen clothing. Have patient drink 1 - 2 cups water immediately, and every 20-minutes thereafter, until symptoms subside. Total water consumption should be 1 - 2 gallons per day. Consult with physician.

### 9.6 Heat Rash

Heat rash is caused by continuous exposure to heat and humid air and aggravated by chafing clothes. The condition decreases ability to tolerate heat.

- **Symptoms:** Mild red rash, especially in areas of the body in contact with protective gear.
- **Treatment:** Decrease amount of time in protective gear, and provide powder to help absorb moisture and decrease chafing.

### 9.7 Heat Stress Monitoring and Work Cycle Management

For strenuous field activities that are part of on-going site work activities in hot weather, the following procedures shall be used to monitor the body's physiological response to heat, and to manage the work cycle, even if workers are not wearing impervious clothing. These procedures are to be instituted when the temperature exceeds 70°F.

- **Measure Heart Rate (HR).** Heart rate should be measured by the radial pulse for 30 seconds as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 110 beats/minute. If the HR is higher, the next work period should be shortened by 33%, while the length of the rest period stays the same. If the pulse rate still exceeds 110 beats/minute at the beginning of the next rest period, the following work cycle should be further shortened by 33%. The procedure is continued until the rate is maintained below 110 beats/minute.

### 9.9 Frostbite

- Local injury resulting from cold is included in the generic term frostbite. Frostbite of the extremities can be categorized into:

- Frost nip or incipient frostbite is characterized by sudden blanching or whitening of skin.
- Superficial frostbite is characterized by skin with a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.
- Deep frostbite is characterized by tissues that are cold, pale, and solid.

To administer first aid for frostbite: Take the victim indoors and rewarm the areas quickly in water that is between 39°C and 41°C (102°F-105°F). Give a warm drink - not coffee, tea or alcohol. The victim must not smoke. Keep the frozen parts in warm water or covered with warm clothes for 30 minutes, even though the tissue will be very painful as it thaws. Then elevate the injured area and protect it from injury. Do not allow blisters to be broken. Use sterile, soft, dry material to cover the injured areas. Keep victim warm and get immediate medical care.

After thawing, the victim should try to move the injured areas a little, but no more than can be done alone, without help.

Note:

- Do *not* rub the frostbitten part (this may cause gangrene).
- Do *not* use ice, snow, gasoline or anything cold on the frostbitten area.
- Do *not* use heat lamps or hot water bottles to rewarm the part.
- Do *not* place the part near a hot stove.

### 9.10 Hypothermia

Systemic hypothermia is caused by exposure to freezing or rapidly dropping temperature. Its symptoms are usually exhibited in five stages:

- Shivering
- Apathy, listlessness, sleepiness, and (sometimes) rapid cooling of the body to less than 95°F
- Unconsciousness, glassy stare, slow pulse, and slow respiratory rate
- Freezing of the extremities
- Death

As a general rule field activities shall be curtailed if equivalent chill temperature (°F) as defined in Exhibit 9-1 is below zero (0°F) unless the activity is of an emergency nature.



# **ATTACHMENT 1**

## **SITE SPECIFIC AIR MONITORING PLAN**

# **PRELIMINARY SITE SPECIFIC AIR MONITORING PLAN**

FOR

## **INTERIM ACTION ROCKY MOUNTAIN ARSENAL BASIN F**

May, 1987



Submitted to: U.S. Army Corps of Engineers Omaha District



Submitted by: Woodward-Clyde Consultants  
in association with  
HDR Infrastructure, Inc.



**AIR MONITORING PLAN**  
**FOR**  
**BASIN F**  
**ROCKY MOUNTAIN ARSENAL**

# TABLE OF CONTENTS

Section No.	Title	Page No.	Page
1.0	Introduction	1	1-1
2.0	Personnel Qualifications	2	1-2
3.0	Objectives	3	1-2
4.0	Sampling and Monitoring Strategy	4	1-3
5.0	Sampling and Monitoring Methods	5	1-3
6.0	Instrumentation	6-9	1-5
7.0	Accuracy Levels	10	1-5
8.0	Sample Collection and Analysis	11	1-26
9.0	Recordkeeping	12	1-26
10.0	Meteorological Monitoring	13	1-28
11.0	Quality Assurance/Quality Control	13	1-29

## Air Monitoring Plan

### 1.0 INTRODUCTION

This Air Monitoring Plan has been prepared in accordance with guidelines contained in the USEPA Standard Operating Safety Guides, November 1984, USEPA Air Surveillance for Hazardous Materials, Office of Emergency and Remedial Response and NIOSH Manual of Analytical Methods. It also addresses the guidelines set forth in the US Army Corps of Engineerings document, Interim Standard Operative Air Monitoring for Hazardous Waste Sites. The Corps of Engineers (COE) Guidelines have been followed or directly inserted into the Air Monitoring Plan. Reference is made to each section of the COE document being addressed in the Table of Contents by the notation COE 1 or Corps of Engineers Section 1. Evaluation of Organic Vapor Emissions at Basin F by the United States Army Environmental Hygiene Agency, Aberdeen Proving Ground, Maryland also serves as the reference for sampling methods and analytical procedures outlined in the Air Monitoring Plan.

#### 1.1 Purpose of the Plan

The purpose of this air monitoring program is to ensure the adequate protection of both the field team and the surrounding areas. Work area air monitoring (within the exclusion zone) will be conducted to determine if action levels are being exceeded. If this happens, engineering controls will be initiated or workers will upgrade to the appropriate level of protection. Upwind and downwind off-site and perimeter monitoring will be conducted to determine if measurable

A combination of on-site, off-site, perimeter and work area samples will be used to assess the potential for release of air contaminants. While the primary objective of on-site air monitoring is to insure that personnel visiting or working on the site are adequately protected from airborne hazards, this data can also be used to assess the potential of detectable off-site releases of air contaminants. For example, even if on-site workers, with appropriate protection, are exposed to the PEL or TLV, significant, or even detectable, off-site release of air contaminants may not occur due to the enormous dilution volume of air in an outdoor work environment. Use of direct reading instrumentation and area samples at site perimeter locations can verify the absence or degree of off-site chemical releases after being corrected for background baseline data.

To establish background levels of air contaminants in the vicinity of Basin F, the initial step will be to monitor and sample in an upwind area which is far enough removed from the site not to be influenced by chemical releases on site. It is also important to avoid locations such as freeways, active industrial sites, etc., that are readily accessible but may not give an accurate picture of prevailing conditions in clean areas nearby. Background levels of the Basin F area may be above expected ambient air quality due to possible upwind contamination from other contaminated areas on the Rocky Mountain Arsenal. These location precautions are necessary to aid in the separation of air contaminants generated by the site from those contaminants generated by other off-site sources. If this is done properly, it will be possible to determine if contaminants are leaving the site.

The monitoring locations are intended to detect any off-site migration of particulates and organics caused by the Basin F Interim Remediation Activities and protect persons outside of the exclusion zone.

#### 4.1.1 Real Time Instrument Monitoring

Monitoring at background locations will be conducted once each workday following the establishment of background value for each of the monitoring instruments. Ambient background levels will be established during monitoring which must be conducted at the upwind off-site monitoring station. The mean value of three separate readings will be considered background for action level reference.

Monitoring at downwind locations will be conducted twice each workday. This data will assist the Air Monitoring Specialist in determining the types and frequency of analysis necessary for off-site area sampling. Direct reading, real time instruments to be used for off-site monitoring will include the OVA, HNU, RDM, and GVM.

#### 4.1.2 Off-Site Sampling

Off-site air samples will be collected at the monitoring stations to determine if migration of specific pollutants is taking place. Both upwind and downwind samples will be collected during each sampling

#### 4.2.1 Real Time Instrument Monitoring

Monitoring around the exclusion zone perimeter will be conducted at stations which will be located in the field by the Air Monitoring Specialist. In general, three stations should be located along the downwind site and one on the upwind side of the exclusion zone to correspond with the predominant annual wind directions. Two stations will also be located on the crosswind sides of the site.

Monitoring at these locations will be conducted three times each workday following the establishment of a background value for each of the monitoring instruments at the stations. Background values will be established for each perimeter monitoring station each day prior to any on-site activities. Instruments to be used for perimeter monitoring will include the OVA, HNU, RDM, Tri-Level Detector and GVM.

#### 4.2.2 Perimeter Sampling

Perimeter sampling will be done in accordance with the NIOSH Manual of Analytical Methods and those established by the USAEHA for Basin F.

Both upwind background samples and downwind samples will be collected at a frequency of one per day for an eight hour duration. Results from real time monitoring can be used to determine whether all the samples need



#### 4.3.1 Liquid Removal Area

The liquid portion of Basin F is to be removed and pumped to large storage tanks. The pump installation and liquid transfer operation will potentially generate particulates, mist and vapor. Because of this the liquid removal area will require monitoring with the PID or FID and RDM.

#### 4.3.2 Waste Pile Area

Temporary storage of the bottom sludge will take place in a designated waste pile. The potential for generation of particulates from this activity exists and will require monitoring with the PID or FID and RDM.

#### 4.3.3 Excavation/Absorption Area

The sludge removal, mixing and absorbent addition activities have the potential to generate both organic vapors, ammonia, and particulates. Because of this monitoring of the area will be required with the PID or FID, RDM and GVM.

#### 4.3.4 Work Area Monitoring

Continuous monitoring in these areas for air contaminants will be required by use of a FID, RDM, GVM and PID throughout the workday when area activities are taking place. In addition to continuous monitoring, some random monitoring with the Radmeter and Tri-Level

Downwind samples will be collected at a frequency of one sampling event every day at each of the work areas to determine what activity is generating the off-site contamination problem. A minimum duration for sample collection will be eight hours, a full workshift single sample, at a pumping rate necessary to obtain the required air volumes for the SAB and PAB tubes as described in Section 5.1.

At a minimum analysis of work area sample tubes will be conducted for the priority pollutant volatiles, base/neutrals, acids, pesticides, ammonia, and all of the compounds identified on Table 1 as being present in Basin F.

## 5.0 SAMPLING AND MONITORING METHODS

### 5.1 Monitoring Methods

Because of the large number of organic and inorganic compounds which could be encountered during the Basin F Activities, the air monitoring methods will require the use of direct reading instruments that are portable and safety-rated for a hazardous waste sites will be used. Direct reading, real-time instruments will be used to determine total gases, vapors, gamma radiation, combustible gas, ammonia, and total particulate concentrations.

Ambersorb. See Figure 5.2. The PAB and SAB are branches of the U.S. Army Environmental Hygiene Agency, Aberdeen Proving Ground, Maryland.

The PAB sample tube is located at one of the inlets and consists of a single tube. Two SAB sample tubes are in series at the other inlet with one serving as the primary and the other as backup should a slip of volatiles on the primary occur.

The suction lines from the collection tubes connect to a common manifold and to the sample pump. The pump is operated by a portable electric battery pack. A copy of the USAEHA's Reference document provides detailed discussion of the sampling and analytical methods for Basin F, see Reference #14.

### 5.3 USAEHA's Findings

A brief summary of additional USAEHA's findings on air sampling and analysis methods to be used at Basin F reads as follows:

- A considerable amount of information has been compiled characterizing the composition of the Basin F liquid and organic compounds likely in the Basin F vapor.
- The SAB (Tenax and Ambersorb Sorbent) sample tubes developed in this study provide acceptable retention and recovery of a wide range of organic vapors. Sample volume for the SAB tubes should be increased to the maximum convenient volume - 0.6 L/min for eight hours for a total of 290 L. This volume

is more than 10 times the EPA suggested sample volume but provides greater sensitivity within acceptable retention requirements.

- The SAB tubes should be analyzed by operating the mass spectrometer in the selected ion monitoring mode for known target compounds such as DMMP, dieldrin, and aldrin. Under these conditions, detection levels of  $0.001 \text{ ug/m}^3$  are attainable. Total ion monitoring mode for other organics on the mass spectrometer will produce a detection level about  $0.1 \text{ ug/m}^3$ .
- After careful review of data on Basin F vapor organics, recommended target compounds have been selected for field monitoring. These are listed in Table 1. Pertinent mass spectral information exists for each compound. A column is included in Table 1, which gives the basis for selection of the compound. The list was tentative at the time of the USAEHA's publication.
- The sample manifold devised for in-house tests should be used in field work. This arrangement permits assessment of organics breakthrough from primary to backup tubes and indicates the precision of the measurement when all tubes are analyzed because of the dual sample tubes. Backup tubes are required because sampling conditions may differ in the field. These tubes are also useful for spiking standard compounds in test evaluation.

- The PAB (Chromosorb 102 Sorbent) tube provides excellent and reproducible recoveries for dieldrin, aldrin, and endrin. With sample volumes on the order of 2000 L, detection levels for the insecticides listed above should approach 0.007, 0.005, and 0.01 ug/m<sup>3</sup>, respectively.
- Use of both the SAB (Tenax and Ambersorb Sorbent) and PAB (Chromosorb 102 Sorbent) tubes can provides two independent sampling methods for the pesticides dieldrin, aldrin, and endrin. These compounds were detectable constituents in both the Basin F liquid and in vapors produced in laboratory tests.

## 6.0 INSTRUMENTATION

Designated site technicians will be responsible for operating the air monitoring instrumentation under the supervision of the Certified Industrial Hygienist, and Air Monitoring Specialist. These designated individuals will be required to demonstrate proficiency in the use, care, limitations, and operating characteristics of monitoring instrumentation during the pre-activity site-specific health and safety training.

The following instrumentation will be available on the Basin F site:

<u>Item</u>	<u>Specs</u>
Flame Ionization Detectors (FID)	Total Organic Vapors
Photo Ionization Detectors (PID)	Total Organic Vapors
Respirable Dust Monitor (RDM)	Particulates
Tri-Level Detectors	Combustible Gases, O <sub>2</sub> , H <sub>2</sub> S
Radmeter	Radiation
Gas and Vapor Monitor (GVM)	Ammonia
Portable Air Pumps	3 L/min

### 6.1.1 Startup

1. Disconnect instrument from battery charger.
2. Connect the probe by attaching the sample line and electronic jack to the sidepack.
3. Lift and move INSTR switch to the BATT position to check battery. If the meter needle does not move beyond the white line, recharge the battery.
4. Lift and move INSTR switch to the ON position and allow a five minute warm-up.
5. Lift and move PUMP switch to the ON position.
6. Lift and move the CALIBRATE switch to the X1 position and adjust the meter needle to 1 using the ZERO knob.
7. Open the Hydrogen TANK VALVE and Hydrogen SUPPLY VALVE one or two turns.
8. For OVA Model 128: Check that the SAMPLE INJECT valve is in the full "out" position (up) and that the BACKFLUSH valve is in either the full "in" (down) or full "out" (up) position.
9. After approximately one minute, depress the Igniter Button until the hydrogen flame lights. Do not depress igniter for more than six seconds. If flame does not ignite, wait one minute and try again.

### 6.1.2 Alarm Set

Note: INSTR and PUMP switches must be in ON position when setting alarm. Alarm can be set before or after startup.

1. Use the Calibrate Adjust Knob (on back of probe) to set the meter needle to the level desired for activating the audible alarm. If meter needle is set at "5" ppm, alarm will also sound at "50" and "500" ppm.
2. Turn the Volume knob fully clockwise.

## 6.2 Photoionization Detector

The HNU, Photoionization Detector (PID) can detect organic hydrocarbon gases in the range from 1.0 to 2,000 ppm. The HNU is a portable, direct-reading instrument which is simple to use. HNU's with 10.2 eV light sources will be utilized to detect compounds with ionization potentials below 10.2 eV. An 11.7 eV probe is also available to allow for detection of a wider variety of compounds however, it is not as sensitive as the 10.2 eV probe. Operating problems may occur with the HNU during rainy or extremely humid conditions. In that case, only the OVA would be relied upon.

### 6.2.1 Startup

1. Check that the function switch on control panel is in the off position.
2. Attach the probe by carefully matching the Alignment Key in the probe connector to the 12-pin connector on the control panel, and then twisting the probe connector until a distinct snap and lock is felt. Record which probe was attached (e.g. 10.2 eV probe).
3. Turn the function switch to the battery check position. If the meter needle is not within or above the green battery arc on the scale, recharge the battery. If the red indicator light comes on, recharge the battery.
4. Turn the function switch to any range setting. Look into the end of the probe briefly to see if the lamp is on. If it is on, it will give a purple glow. Do not stare into the probe for any length of time as UV light can damage your eyes. The instrument is now ready for operation.
5. Check and record the span pot setting. A setting of 9.8 corresponds to benzene calibration.

### 6.3 Respirable Dust Monitor

Respirable Dust Monitors (RDM) are direct reading, real time instruments which indicate the concentrations of respirable (0.2-40u) dust will be used. An example of such an instrument is the TSI 3500 dust meter which is a portable unit capable of being operated in the field or a similar approved unit.

### 6.4 Tri-Level Detector

The Tri-Level Detector is a three-way gas detector that monitors for combustible gases, oxygen, and hydrogen sulfide. It is portable, lightweight, fully automatic, and gives a characteristic warning signal when present levels of combustible gas or deficient oxygen conditions are detected. It can detect and indicate combustible concentrations up to the lower explosive limit, hydrogen sulfide concentrations up to 60 ppm, and oxygen over a range of 0 to 25%. It is factory calibrated.

### 6.5 Radiation Detector

The Radmeter low level gamma scintillator detects gamma radiation from 0 to 25 mR/hr through 0 to 5,000 mR/hr in five ranges. It is a portable, light-weight instrument which is calibrated in the factory.

### 6.6 Gas and Vapor Monitor

Because of the anticipated generation of Ammonia from the site activities, a portable air monitor specific to Ammonia will be used.



Soap bubble flow meter represents a primary standard and is used to calibrate the types of sampling pumps discussed earlier, as well as the manually operated pumps used for direct reading colorimetric tubes. This device typically consists of an inverted graduated burette connected by flexible tubing to the sampling train. Calibration is performed as follows: The system's pump is started creating airflow into the burette. The open end of the burette is dipped into a soap solution creating a soap film bubble across the opening. The solution is removed, and the bubble is allowed to rise up through the burette. Travel time of the bubble between two graduated points on the burette is measured. The flow rate (measured in cc's/minute) is varied by adjusting the pump flow regulator. See Figure 6.1.

For further information consult the NIOSH Manual of Analytical Methods for calibration of sampling pumps as well as the manufacturers recommendations on operation and calibration.

#### 6.8 PAB and SAB Tubes

The USAEHA has established suitable tubes for sample collection at Basin F. The selected packing for the PAB tubes is Chromosorb 102 and the SAB tubes developed contain Tenax and Ambersorb.

#### 7.0 ACTION LEVELS

Action levels for off-site monitoring will be determined by the readings recorded on the real time monitoring instruments specified in this plan. Laboratory analysis of the sampling tubes will not have action levels associated with them. These analysis will be used to determine what, if any, the release was. Evacuation decisions will be based on real time instruments and previous laboratory analysis of the sampling tubes.

Appropriate modification of the levels of personal protection and frequency of testing could be implemented by the CIH if deemed necessary to protect the workers in the exclusion zone and others outside of the zone. The CIH shall modify this plan to meet the needs of the project and protect the health and safety of workers.

## 8.0 SAMPLE COLLECTION AND ANALYSIS

Except for direct reading instruments sample collection and analysis will be done in accordance with the NIOSH Manual of Analytical Methods, Vol. I-VII. Deviations are discussed in the USAEMA's development document for Air Sampling and Analysis of Organic Vapor Emissions at Basin F (Reference 14, Part I of the document). Further discussion on sampling and analysis methods is in Section 11.

## 9.0 RECORDKEEPING

An important aspect of any data generation effort is accurate record keeping. The Air Monitoring Specialist will be responsible for the completeness and storage of all records. Forms will be developed by the Air Monitoring Specialist to record pertinent data on and they should contain as a minimum the following information:

### 9.1 Air Sampling Data Sheet

- Site Location/Date
- Work Area/Operation Name
- NIOSH Method Used
- Air Flow Calibration Record
- Instrument Calibration Record
- Temperature, Pressure, Humidity at Sample Location
- Area/Sampling Location Diagram
- Area Sample Description/Location
- Sampling Data

### 9.3 Photographic Records

Photographs and description summary will be included with the final report. They will be used to document the sampling program, unusual sample appearances or locations, and site peculiarities. A chalk/marker board will be included in the photo to identify the photo. Information on the board should include a sample number, date, time, sample location, photo and roll number. Photographs other than those for sampling, will also be included in the daily log book with the following information:

- Date and time
- Photographs
- Name and identification of site
- General direction faced and description of subject (if applicable)
- Location of site
- Sequential number of the photograph and the roll number

### 9.4 Final Report

A final report document shall be prepared by the AMS and shall be submitted to the CIH as a part of the project records.

This document must contain the following information:

- Chain of Custody
- Laboratory results
- Meteorological data
- Daily field log
- Air sampling and monitoring forms
- Equipment Calibration and maintenance records

For simplicity, the sample numbers should be assigned in sequential order. If, for any reason, a sample number is not used, an explanation of the reason will be included in the log book(s), and noted as UNUSED.

Sample container packaging and shipment are to be in accordance to EPA, Standard Operating Safety Guides, November 1984 and Department of Transportation requirements and regulations.

Samples shall be placed in D.O.T. approved coolers of metal or hard nonbreakable plastic.

D.O.T.'s standard requirements for all packages are specified in 49 CFR 173.24. These requirements state that: "Each package used for shipping hazardous materials...shall be so designed and constructed, and its contents limited, that under conditions normally incident to transportation:

- "There will be no significant release of the hazardous materials to the environment;
- "The effectiveness of the packaging will not be substantially reduced; and
- "There will be no mixture of gases or vapors in the package which could, through any credible spontaneous increase in heat or pressure, or through an explosion, significantly reduce the effectiveness of the packaging."

#### 11.1.1 Classification

Using DOT guidelines, samples sent to the lab from the site will be classified as follows:

## 11.2 Chain of Custody Procedure

Written records of the sample handling will be kept each time the sample change hands. Each person in custody of the sample will be required to document the transfer on the Chain of Custody Records. Fill out records and send original along with the lab samples. The procedure includes:

- Collect sample
- Fill out field records
- Make necessary entries in log book
- Label samples
- Fill out Chain-of-Custody sheet (each person taking Custody of the sample(s) must sign the Chain of Custody sheet)
- Place sample(s) in transportation case along with chain of custody (sealed in a plastic bag and taped to the inside of the lid), pertinent field records, analysis request form (all sealed in waterproof bags)
- Sign and affix custody seals in two places on outside of cooler - one in front, one in back
- Seal or lock case and secure with tape
- Ship samples according to DOT regulations

## 11.3 Documentation

### 11.3.1 Daily Field Log

The AMS is accountable for all log books, sample tags, chain-of-custody records, correspondence, analytical records, photos and any other related materials. Upon project completion, all the above mentioned correspondence will be turned over to the CIH for incorporation into the final report. A daily field log will be kept in addition to the air sampling form and air monitoring form.

on a document should be corrected by the person who made the entry. All corrections must be initialed and dated.

#### 11.4 Field Sample QC

In addition to the sample collection and analysis procedures, shipping and chain-of-custody described in the Air Monitoring Plan, a field check needs to be used. As a result field blanks will be prepared at the same time as sampling takes place. Field blank tubes should come from the same lot as those used for collection. They will be packed and shipped exactly as the air samples without air being drawn through them. One field blank is required for each 10 samples taken.

Take one downwind replicate sample for every set of field samples to assure quality of the sampling procedures. The replicate sample should be exposed to the same environment as the primary sample. The quality control samples must be taken with the same equipment procedures and personnel used in the routine field samples. The relative standard deviation,  $s_r$ , calculated from these replicates should be recorded on control charts and action taken when the precision is not within the quality control limits.

Sample collection, packing and shipping procedures will be taught to all persons involved in air monitoring by the AMS. This will ensure program consistency.

pollutant volatiles, based/neutrals, acids and pesticides in addition to all compounds identified on

Table 1.

11.	(Chloroacetophenone) 1-(2-Chlorophenyl) Ethanone	C <sub>8</sub> H <sub>7</sub> OCl	C <sub>1</sub> C <sub>6</sub> H <sub>4</sub> COCH <sub>3</sub>	No	
12.	Acetamide	C <sub>2</sub> H <sub>5</sub> NO	CH <sub>3</sub> CONH <sub>2</sub>	No	
13.	Benzaldehyde	C <sub>7</sub> H <sub>6</sub> O	C <sub>6</sub> H <sub>5</sub> CHO	No	
14.	Benzonitrile	C <sub>7</sub> H <sub>5</sub> N	C <sub>6</sub> H <sub>5</sub> CN	No	
15.	Nitromethane	CH <sub>3</sub> NO <sub>2</sub>	CH <sub>3</sub> Cl	No	
16.	Chloromethane	CH <sub>3</sub> Cl	CH <sub>3</sub> Cl	No	
17.	Benzene Methanol, -Methyl	C <sub>8</sub> H <sub>10</sub> O	C <sub>6</sub> H <sub>5</sub> CH(CH <sub>3</sub> )OH	No	
18.	1,4-Dithiane	C <sub>4</sub> H <sub>8</sub> S <sub>2</sub>	C <sub>4</sub> H <sub>2</sub> S <sub>2</sub>	No	
19.	Dimethyl Trisulfide	C <sub>2</sub> H <sub>6</sub> S <sub>3</sub>	CH <sub>3</sub> SSSCH <sub>3</sub>	No	
20.	Acetic Acid, Phenyl Methyl Ester	C <sub>9</sub> H <sub>10</sub> O <sub>2</sub>	C <sub>6</sub> H <sub>5</sub> CH <sub>2</sub> O <sub>2</sub> CCH <sub>3</sub>	No	
21.	Chlorobenzonitrile	C <sub>7</sub> H <sub>4</sub> NCI	C <sub>1</sub> C <sub>6</sub> H <sub>4</sub> CN	No	
22.	1-Chloro-4-(Methyl- sulfonyl) Benzene	C <sub>7</sub> H <sub>7</sub> SO <sub>2</sub> Cl	C <sub>1</sub> C <sub>6</sub> H <sub>4</sub> SO <sub>2</sub> CH <sub>3</sub>	Yes	Highest Basin F Constituent
23.	Diisopropyl Methyl Phosphonate	C <sub>7</sub> H <sub>17</sub> PO <sub>3</sub>	CH <sub>3</sub> P(O)(OC <sub>3</sub> H <sub>7</sub> ) <sub>2</sub>	No	
24.	Phosphoric Acid, Triethyl Ester	C <sub>6</sub> H <sub>15</sub> PO <sub>4</sub>	(C <sub>2</sub> H <sub>5</sub> O) <sub>3</sub> P(O)	No	
25.	Bicyclo(2.2.1) Hepta-2,5-diene, 1,2,3,4,7,7-Hexachloro	C <sub>7</sub> H <sub>2</sub> Cl <sub>6</sub>	--	Yes	Toxicity